THE EFFECTS OF TEACHING SIMULTANEOUS OR SUCCESSIVE WORD PROCESSING STRATEGIES ON READING RECOGNITION AND SPELLING IN STUDENTS DEFICIENT IN EITHER SIMULTANEOUS OR SUCCESSIVE PROCESSING SKILLS

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PREFACE

Effectively employing methods to remediate the learning and behavioral problems of children has always been a concern of psychologists in the schools. This study sought to investigate the relevance of the Luria-Das neuropsychological model of simultaneous and successive cognitive processing of information to educational practice. The relevance of this theory to educational practice was investigated by determining if there were differential effects in teaching simultaneous or successive word processing strategies to children deficient in simultaneous or successive processing skills. It was found that it made little difference whether or not children with deficits in simultaneous or successive information processing were prescribed simultaneous or successive word processing strategies. The translation of this information processing theory to educational practice is still tentative and experimental. This study should be of interest to those investigating the Luria-Das information processing model and persons using the Kaufman Assessment Battery for Children which is based, in part, upon notions underlying this model.

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CHAPTER I

THE RESEARCH PROBLEM

Introduction

Traditionally, one mainstay of the practice of psychology in the schools has been to identify children who have difficulties learning and adjusting to the school environment and to employ procedures to foster learning and adjustment. The methods generally employed to foster such change could be said to stem from one of two basic orientations. The first orientation would dictate the need to alter either the behavior presented by the student through external contingencies (e.g., Skinner, 1974; Premack, 1959) or to alter the environment itself, or the opportunities afforded by the environment, to enhance learning and adjustment (e.g., Bandura, 1977; Miller and Dollard, 1941). In this case, the observer of the behavior exhibited by the child is the active "therapist" or change agent. The technology for such means of controlling or altering learning and adjustment problems comes directly from the behavioral or environmental-learning disciplines in psychology.

The second orientation dictates the need to alter something within the child. The emphasis here is to alter directly the mental behavior of an individual which might be impeding learning or adjustment. Primarily, this has taken the form of using internal language to direct behavior (e.g., Meichenbaum, 1977; Meichenbaum & Goodman, 1971). The need to focus on the application of such procedures to solve a variety of learning problems has received support from the literature (Craighead, 1982; Lloyd, Kosiewicz, & Hallahan, 1982). As Lloyd (1980) has described such procedures, students are taught to be their own therapists, trainers, and teachers. The manner in which this is done is to teach children the internal language necessary to establish a smooth flowing process which allows them to succeed in solving a broad class of problems. The processes are taught in the hope that the use of the processes will directly affect the learning or adjustment problems on which the process was focused and that the use of the process will transfer to a similar class of tasks. Stated more simply, given that the solution to a learning or adjustment problem requires a number of steps which can be monitored by self-statements, the steps or self-statements to direct these steps are taught directly so the child can maintain covert control of himself or herself while working that behavioral or learning task. Essentially, internal language is taught which can direct behavior. The execution of control and strategy is placed within the student.

The procedures for fostering internal control have generally been termed cognitive behavior modification (Lloyd, 1980). The impetus for exploring the teaching of internal language driven control stems from the powerful demonstrations of investigators such as Luria (1961, 1981) and Vygotsky (1962) which show the self-control function of language to develop after the use of language begins. Language and behavior are seen to develop as separate systems which later merge and affect one another. At times, this merger must be facilitated. It appears the teaching of cognitive processes may not be limited to teaching of internal language as advocated by Luria and Vygotsky.

During the 1970s, a number of studies were published which described modes or types of cognitive processing of information. Many of these studies were designed to confirm the existence of what the late A. R. Luria, a Soviet neuropsychologist, observed as simultaneous and successive cognitive processing of information. An expanded model of simultaneous and successive cognitive processing was introduced by J. P. Das (1973b), and the work of Das, his associates, and his students culminated in the publication of a book describing and validating the existence of these processes (Das, Kirby, & Jarman, 1979). The Luria-Das neuropsychological model posits that the brain can be understood as three functional units or blocks. One unit is associated with arousal and attention. Another unit is associated with planning and decision making. Yet another unit is associated with the coding and synthesis of information. The forms of coding are termed simultaneous and successive synthesis or processing of information (Das, Kirby, & Jarman, 1975, 1979; Luria, 1970, 1973). What intrigued Das, Kirby, and Jarman was, in part, that not only were the information processing mechanisms described in a fashion which suggested a mode of teaching the cognitive processes, but that the existence of the processes was based in extensive neurological research (e.g., Luria, 1973). A variety of studies have indicated the processes are variables of interest in academic performance (e.g., Cummins and Das, 1977; Kirby & Das, 1977) and that the processes may be taught (e.g., Hobby, 1981; Kaufman, 1978; Kaufman & Kaufman, 1979; Krywaniuk, 1974).

Contrasting Views on Modifying Cognitive Behavior

Das and many persons researching the Luria-Das model of intellectual processes have by no means been the only ones to label and investigate intellective or cognitive processes. Further, they are not the only persons who have attempted to teach or alter cognitive processes to the betterment of academic achievement or to gain a fuller understanding of the learning problems of a student. Work in this area can be described as representing three general views. Neither view is totally different from others to be described.

Mediated Learning

The first view represents the effort to mediate cognitive activity of a learner and to better understand the types of information (content) a learner understands, how they use such information, and how ably a learner can convey information in the form of some product. Work in this area is best represented in Feuerstein, Rand, & Hoffman (1979, 1980) and Budoff (1975). These clinicians believe that one should not focus on static psychometric scores as the IQ to set the direction of educational programming or to infer how much a learner can learn in the future. Rather, any assessment which is done is for the purpose of observing the processes used by the learner to solve problems so one can properly attend to whatever mediational defects that might prevent learning with the goal of teaching needed thinking behavior. This constitutes one portion of learning potential assessment (Hennessy, 1981). Feuerstein, et al., (1979, 1980) have developed the Learning Potential Assessment Device (LPAD) which allows the opportunity to shift from a product to process testing and assessment orientation (Feuerstein, et al., 1981). The LPAD approach is based on a conceptual model of the mental act referred to as a cognitive map. This map is used as an analytical tool to locate points of learning difficulty and to see changes which take place in learning as a result of training for retarded learners.

The cognitive map is made up of content or subject matter presented to the learner, modality of the conveyed subject matter, operations or structural components of the mental act to be performed, phase or cognitive prerequisites necessary to complete a mental act, levels of complexity required for a completing a given mental act, level of abstraction needed to perform an act, and level of efficiency constituting how crystallized or automatic a mental act is (Feuerstein, et al., 1981). There are numerous measures used in the LPAD and each has a pretest and training phase. Learning which has taken place after training amounts to the learning potential assessment and the pretest and training phases allow for an inspection of a learner's cognitive map. The underlying construct of Feuerstein's work is that there is really no such thing as retarded behavior. Rather, there are children who have not learned mediational skills which are as fundamental as learning content skills such as properly recognizing a letter of the alphabet. The complete use of the LPAD can take quite a long time (thirty hours when adapted for a deaf child reported by Katz & Buchholz, 1984).

Feuerstein's LPAD has been favorably received in concept and practice (Harth, 1982; Katz & Buchholz, 1984; Waksman, Silverman, &

Weber, 1983). Unfortunately, validation of the LPAD or demonstrations of its use has only been reported for very diverse groups (e.g., prisoners in Waksman, et al., 1983; one deaf girl, Katz & Buchholz, 1984) and results of studies have been presented in nontraditional ways leaving the effects of mediation training as speculative and clinical (e.g., Feuerstein, Miller, Rand, & Jensen, 1981). Proponents of learning potential assessment or the LPAD do not have an overwhelming list of published studies exemplifying the mediational potential of this technique or the need to use such a devise in lieu of mainstream psychometrics or other testing-teaching techniques.

Cognitive Modifiability

The second view discussed here deals with the modifiability of cognitive activity. The cognitive activity represents general styles or tendencies which people have in carrying out cognitive acts as opposed to the very specific and atomistic mental behaviors of interest in learning potential assessment. Most work in this area is seen in studies of cognitive styles of children (e.g., Paley, 1964; Saracho & Dayton, 1980; Shade, 1983; Snyder & Butler, 1985; Vaidya & Chansky, 1980). The term cognitive style is used to describe individual differences noted in the processes of perceiving, remembering, thinking, and judging (after Kogan, 1976). Investigators have used various tests to label and define cognitive style preferences of children (see Kogan, 1976 for a review). Among styles which have been identified are field independence-dependence (e.g., Witkin, Goodenough, & Karp, 1967), reflection-impulsivity (Kagan, Rosman, Day, Albert, & Phillips, 1964), and breadth of categorization (Kagan & Kogan, 1970;

Kogan, 1971). Various other cognitive styles are reported in the literature. Guilfòrd (1980) offers a review and questions whether or or not differences in perceiving, remembering, thinking, and judging can be explained more parsimoniously than with all of the labels for cognitive styles which have been developed.

Investigators have noted that children having particular cognitive styles achieve better in the normal school setting (e.g., Shade, 1983). Also, matching cognitive styles of teachers with cognitive styles of students somehow has produced results of better achievement in field independent children (Saracho & Dayton, 1980). Further, there has been a relative amount of success in modifying cognitive styles which are not particularly adaptive (as being impulsive or dependent on outside structure to learn) usually reflected in the tests used to measure the styles (e.g., Briggs & Weniberg, 1973; Butler, 1979; Cohen & Przybycien, 1974; Debus, 1970; Egeland, 1974; Johnson, Flinn, & Tyer, 1979, Kendall & Frick, 1978; Kirby & Lawson, 1983; Learner & Richman, 1984; Linden, 1973; McAllister, 1970; McCanne & Sandman, 1976; Moore & Cole, 1978; Pelletier, 1974) and it has been shown that for the most part, at least in adults, cognitive styles are relatively independent of standard notions and tests of "abilities" and "aptitudes" (Federico & Landis, 1984). Furthermore, as Blackman and Goldstein (1982) have summarized in reviewing much of the work in cognitive styles, children not dependent on outside structure (field independent) and who are reflective in their thinking do perform better in school. Typically, underachieving children need structure (are field dependent) and are impulsive in their cognitive styles. Reflective children demonstrate superior attentional behavior relative to impulsive children. Children requiring less structure in interpreting stimuli (field independent) are superior in analytical thinking. Also, while the relationship between important school behaviors and many cognitive styles has been demonstrated, much of the effects of modifying cognitive styles on actual school performance remains to be shown (Blackman & Goldstein, 1982).

Neuropsychology

The third view related to cognitive behavior stems from brain-behavior correlates discovered by neuropsychology. The theorizing of Das, Kirby, and Jarman (1975, 1979) regarding simultaneous and successive cognitive processing is exemplary of this view. Much controversy has befallen one attempt to codify part of the Luria-Das model of intellective processes into an ability test called the Kaufman Assessment Battery for Children (K-ABC, Kaufman & Kaufman, 1983a) (e.g., Bracken, 1985; Das, 1984; Goetz & Hall, 1984; Keith, 1985; Keith & Dunbar, 1984; Mojovski, 1984; Salvia & Hritcko, 1984). A good deal of validation research not associated with the validation of the test has been conducted (Ayres, 1985; Klanderman, Devine, & Mollner, 1985 and Zins & Barnett, 1984).

Kaufman and Kaufman (1983a, 1983b) have attempted to operationalize two theories of intelligence with the K-ABC. The first theory is the Cattell-Horn theory (e.g., Horn & Cattell, 1966). Kaufman and Kaufman (1983a, 1983b) have divided the K-ABC into two general areas yielding two IQ-type scores. One area is achievement representing the Cattell-Horn notion of crystallized intelligence (Horn & Cattell, 1966). The other area is mental processing representing the

Cattell-Horn notion of fluid intelligence (Horn & Cattell, 1966). Subtests making up the mental processing scales are designed to measure abilities in the use of sequential and simultaneous cognitive processing; that is, measuring ". . . how a person solves a problem mentally. Intelligence on the K-ABC is measured by how well a child uses sequential and simultaneous methods of processing information" (Kaufman, Kaufman, Goldsmith, 1984, Participant Package, p. 2).

The controversy surrounding the K-ABC comes from two directions. One direction is related to the integrity of the test itself. Braken (1985) sees some sequential processing subtests to have nothing to do with how Cattell (1968) describes fluid intelligence. Rather, some sequential subtests measure crystallized intelligence which was supposed to be reserved for the achievement scales. Further, while independent investigations of the factor structure of the mental processing scales do generally support the sequential-simultaneous dichotomy, though the subtest loadings could be labelled as verbal memory and nonverbal reasoning (Keith, 1985). When adding the achievement scales for factor analysis, verbal memory, nonverbal reasoning, and verbal reasoning could be the factor solution (Keith & Dunbar, 1984). Furthermore, the K-ABC achievement scale may better measure verbal ability than achievement and may better measure what more established measures of IQ test (as the Wechsler Intelligence Scale for Children-Revised, WISC-R) than the mental processing scales (Keith, 1985; Swerdlik & Lewis, 1983). Das (1984) complains that a planning dimension should have been included in the test to stay consistent with the Luria-Das model of cognitive abilities so closely emulated. Das (1984) also states that the theory of simultaneous and successive processing would best be operationalized psychometrically by giving children tasks and determining if the tasks are solved with a simultaneous or successive manner of attack rather than by determining how well a child does compared to others on a test designed to require simultaneous or successive processing for its solution. In summary, these researchers and commentators note inconsistencies in what the K-ABC was to measure and what the K-ABC may actually measure.

By far the most controversial area related to the K-ABC in particular and the theory of simultaneous and successive processing in general has to do with translation to educational practice. Large portions of the publications accompanying the K-ABC address ways to teach children with differential abilities in simultaneous or sequential processing (Kaufman & Kaufman, 1983b; Kaufman, Kaufman, & Goldsmith, 1984). The K-ABC has been found to be highly related to achievement (Cooley & Ayers, 1985; Kaufman & Kaufman, 1983b; Murray & Bracken, 1984; Naglieri & Haddad, 1984) and to IQ as measured by the Stanford-Binet and WISC-R (Klanderman, Devine, & Mollner, 1985). The relationship between the K-ABC and old learning has been established in the literature and the test validation project (Kaufman & Kaufman, 1983b). However, as with the mediational learning view and the modifiability view presented already, the educational relevance of the abilities of successive (sequential) and simultaneous processing, emphasized so heavily by Kaufman and Kaufman (1983a, 1983b) have simply not been adequately demonstrated with new learning (Salvia & Hritcko, 1984).

Therefore, translation of information processing theory to manners of teaching based on abilities in simultaneous and successive cognitive processing must be viewed as experimental. In essence, a test (K-ABC) has been published purporting to have serious implications for how a child should be taught. Salvia and Hritcko (1984) have pointed out that past ability training programs, when evaluated, have been found to have no value. Examples offered were the neurological organization programs of Ayers (1972) and Delcato (1966), the perceptual training programs of Frostig (1967) and Getman (1965), the perceptual-motor training programs of Kephart (1971) and Barsch (1967), and finally, Kirk and Kirk's (1971) psycholinguistic training programs.

Numerous suggestions have been offered describing what might be done for a simultaneous or successive learner or what to do when both processes must be involved (Gunnison, Kaufman, & Kaufman, 1982; Kaufman & Kaufman, 1983a). It is clear that the educational relevance of the K-ABC and the model of simultaneous and successive processing of information to educational programming and practice has not been adequately investigated or shown. Kaufman and Kaufman (1983) state "additional research is needed to delineate the ultimate usefulness of the K-ABC for educational intervention" (p. 6). Much research needs to be conducted to demonstrate how cognitive style modification, cognitive mediation, and neuropsychology translates to educational design.

This paper will focus only on the neuropsychological view of translating theory to educational practice and only focus on the theory of simultaneous and successive information processing (Das, Kirby, & Jarman, 1975, 1979). Researching this facet of neuropsychology is important because of the current controversy over the K-ABC and its present use as suggesting educational interventions in the schools.

Studies linking simultaneous or successive cognitive processing and new learning have had unique methodological problems. In studies by Kaufman (1978) and Krywaniuk (1974), children were taught to solve a variety of tasks in the hopes the basic information processing abilities would be improved. In both studies, children were asked to focus more closely on strategies used to solve tasks, and the studies seemed to show that the basic cognitive processes could be improved. Unfortunately, both of these studies focused on successive information processing strategies and were so clinical that the methods would be difficult, if not impossible to replicate. Further, there was no attempt to show that such strategies were better than any others. Leasak, Hunt, and Randhawa (1982) showed information processing training to facilitate reading and arithmetic but the training was restricted to improving simultaneous information processing only. Gunnison and Kaufman (1982) report the results of two studies they claim support remedial intervention programs based on a neuropsychological paradigm (successive and simultaneous information processing). In these studies, learning disabled students who had low successive processing ability and high simultaneous processing ability were administered one of two treatments. One treatment was a reading comprehension strategy designed to capitalize on simultaneous processing strengths and the other was a "traditional" reading instruction program. It is hard to determine what positive results here mean as the reason why a particular "traditional reading instruction program" was picked (or even what it was) was not made clear nor was it clear if the reading comprehension program helped students make more progress because they were high in simultaneous information processing since there was no group representing differential abilities. Hobby (1981) sought to teach learning disabled students with successive processing deficits to process simulated word forms in either a successive manner, a simultaneous manner, or a combination of the two strategies to see which strategy would be more effective for these children and if the training would improve their successive processing skills. The students showed significantly greater performance when taught in the successive strategy on reading the simulated word forms, real words similar to the word forms, and spelling the simulated word forms. As such, there is some indication that the processes can be taught. Unfortunately, many questions are left unanswered about the role of simultaneous and successive information processing in educational practice.

Statement of the Problem

As indicated above, Hobby (1981) found successive word processing training, based on processing simulated word forms, to benefit performance on a measure of successive processing and the reading and spelling of words in children deficient in the successive cognitive processing of information. First, would Hobby's results remain the same for children deficient in successive processing if his method of teaching simultaneous word processing, which failed to affect learning, was better designed to reflect what constitutes simultaneous processing in the Luria-Das cognitive processing model? Second, would children deficient in simultaneous processing benefit more from a successive word processing teaching strategy or from a simultaneous word processing strategy?

Both of these questions are important because it was not fully borne out that Hobby's (1981) successive word processing teaching program was effective due to its being applied directly to children deficient in successive cognitive processing of information. Hobby's (1981) results could be interpreted as showing that a manner of processing words was taught which could be effective for any student regardless of abilities in the simultaneous or successive cognitive processing of information.

Of central importance to persons practicing psychology in the schools is whether particular modes of teaching a process need be prescribed for children with strengths or weaknesses in the successive or simultaneous cognitive processing of information. Therefore, variables which need to be compared are the teaching strategies, based on simultaneous or successive cognitive processing of information, used for children having strengths or weaknesses in the cognitive processing modes, as the treatments affect learning. Hobby's (1981) research was seen here as needing further investigation and elaboration.

Purpose of the Study

The purpose of this study was first to identify two groups of children. One group consisted of children who had difficulties with simultaneous information processing abilities while having no difficulties with successive information processing. One group consisted of children who had difficulties with successive processing abilities while having no difficulties with simultaneous information processing. Second, members of each group were taught to read simulated words by processing those words in one of two ways: either as successive series of letters or as whole forms. That is, teaching strategies were designed and employed to put into play one or the other of the cognitive processes through which it is hypothesized that information is incorporated. Third, the effects of the teaching strategies were evaluated in terms of the childrens' abilities to read the simulated words they had been taught, read words similar to those taught, spell the simulated words, and spell words similar to those with which they were taught. That is, the use of different word processing teaching strategies taught to children having differential strengths and weaknesses in the processing mechanisms were evaluated by performance on the target task and related tasks.

The Need for the Study

The need for such a study is derived from the research base associated with the model of simultaneous and successive cognitive processing; specifically, those studies directed towards the teaching of the processes. Research in simultaneous and successive information processing has shown simultaneous processing abilities related to reading comprehension and math and successive processing abilities to be related to word recognition and spelling (Cummins & Das, 1977; Das & Cummins, 1978; Kirby & Das, 1977; Sprecht, 1976) in correlational studies. However, in a review of the literature, some academic skills are associated with students having adequate capacities in both simultaneous and successive information processing. For example, students having high abilities in simultaneous and successive processing are generally good readers. Students having poor ability in either of the forms of information processing fair less well on tests of reading and students low in both forms of information processing score lowest of all the groups in reading (Kirby & Das, 1977). Leong (1980) has shown measures of both simultaneous and successive information processing to discriminate between "retarded" and below-average readers and between below-average and above-average readers. But in this study the concern was with teaching the processes and viewing how the type of information processing taught in the form of a sight word reading strategy interacts with known strengths and weaknesses of children in both simultaneous and successive processing of information. There is insufficient information of this nature in the literature.

Kaufman and Kaufman (1979) taught both simultaneous and successive information processing strategies to fourth grade students having either average or below-average achievement levels. Students were trained to use successive or simultaneous strategies by verbalizing their strategies to solve puzzles, visual memory tasks, etc., and to verbally summarize strategies. They found a transfer of learning from the training to tests of information processing and to word attack and sight word reading skills. In an investigation by Krywaniuk (1974), successive processing training was provided to children having problems with successive processing and language skills. Students were instructed to verbalize the step-by-step work they used to solve parquetry designs and serial recall tasks and to sequence pictures on a story board, recode sounds heard to symbols, and remember matrices of numerals. The training was found to both facilitate word reading and performance on measures of successive processing. Krywaniuk and Das (1976) showed the training to "reduce the gap" between potential and performance (in terms of explained variance), and factor analysis indicated to the authors that these children were more ably applying successive processing strategies to tasks better solved in a successive manner and applying simultaneous processing strategies more appropriately to tasks requiring such a manner of attack. As Das, Kirby, and Jarman (1979) have noted, both Kaufman (1978) and Krywaniuk (1974) emphasized the use of successive strategies in their intervention programs. Gunnison and Kaufman (1982) reported that learning disabled students with a relative strength in simultaneous processing and a weakness in successive information processing have higher reading comprehension scores when taught with a simultaneous approach rather than a "traditional" reading approach.

Hobby (1981) identified learning disabled students deficient in successive processing, and trained them to process simulated words in a successive teaching strategy, or simultaneous teaching strategy, or a mixture of the two. The students showed significant improvements in successive processing capabilities, sight-word reading of simulated and real words, and spelling of simulated words when training was based on the successive strategy or the mixture of a successive and simultaneous word processing strategy. The methods of attack were taught using simulated word training roughly ten minutes a day for two weeks.

Clearly, more needs to be known about the role of abilities in both simultaneous and successive processing of information in children subjected to treatments to overcome methodological weaknesses shown in other studies. The Hobby (1981) study is preferred as a methodological base as his methods and materials are the most clear, systematic, and straight-forward of intervention studies in this area. Still, Hobby's (1981) study left problems unresolved. First, there was no attempt to control for childrens' abilities in both simultaneous and successive cognitive processing to assess the effects of the strategy training on children who are able or unable in both cognitive processes (see also Gunnison & Kaufman, 1982). Also, the training procedures designed to teach the simultaneous processing of words by Hobby (1981) are suspect in terms of whether they actually taught a process and were aligned with what Das, Kirby, and Jarman (1975, 1979), Kaufman and Kaufman (1983a, 1983b), and Gunnison, Kaufman, & Kaufman (1982) conceptualize as simultaneous processing. Finally, it is also seen that the use of "normal" subjects would allow for more power in interpreting the results and generalizing the results regarding whether the constructs of simultaneous and successive information processing and the design of instructional treatments based on these processing modes should be of concern for psychologists in the schools. Otherwise, matching educational treatments to these information processing variables would be based purely on conjecture rather than sound empirical data.

Definition of Terms

"Simultaneous processing" refers to a manner of processing information. Specifically, it refers to the synthesis or integration of separate bits of information into groups which generally have a spatial nature. All portions of this synthesis are surveyable or accessible without dependence on their position within the synthesis (Das, Kirby, & Jarman, 1975, 1979). Kaufman and Kaufman (1983b) assert that simultaneous or holistic problem solving may be accomplished by processing many stimuli at once and is the capacity to integrate information from different sources to obtain "overviews" of disparate stimuli.

"Successive processing" is the integration of separate information bits into groups whose essential nature is temporal. Portions of the information synthesis are accessible only in the temporal order of the series--each element is dependent on the preceding elements of the synthesis (Das, Kirby, & Jarman, 1975, 1979). Kaufman and Kaufman (1983a, 1983b) view this type of synthesis as arranging input in sequential or serial order. Ideas are linearly or temporally related to the preceding idea.

"Teaching strategy" refers to an organized and systematic manner of teaching information. The teaching is performed identically from one person to the next with no deviations.

"Deficit in information processing" is taken in a normative sense. This is operationalized as the subject scoring at or below the twenty-fifth percentile rank on a measure of one type of cognitive processing while scoring at or above the fiftieth percentile rank for the other type of information processing.

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

Alan S. Kaufman (1979) has noted that there has been little innovation in individual intelligence tests since the time of Binet and that substantive theories and research in related fields such as cognitive psychology and neurology have been ignored in the construction of intelligence assessment devices. His focus in this assertion is that the increasing knowledge that has been gained from the work of persons such as Luria (1970), Sperry (1964) and others to outline the working systems of the brain has not been incorporated into our notions of what constitutes intellectual behavior and the ability to incorporate new information.

Many orientations have emerged to describe the working brain which generally describe modes of information processing or consciousness. Sperry (1964) has dichotomized the processes as analytic versus gestalt. Bogen (1969) has dichotomized the processes as propositional versus appositional. Luria (1966, 1973) has dichotomized the processes as simultaneous versus successive processing. All are attempts to describe the composition of information processing and the use of information. It is of practical benefit, at least according to Kaufman (1979), to understand more adequately and assess a person's abilities based on a comprehensive model of the functional components of the brain. In taking a Western (right-brain versus left-brain) view of the dichotomy or nature of intellectual processes, Kaufman (1979) asserts that "global" intellectual abilities should not be inferred by an IQ score unless that IQ both reflects the systematic measurement of left-brain processing, right-brain processing, and the integration of the two hemispheres. Therefore, well-defined models of how information is processed should ideally incorporate both modes which can be utilized or operated upon by particular areas of the brain and how they are used in intellectual tasks. The K-ABC (Kaufman & Kaufman, 1983a) mental processing scales were derived from what Kaufman considers to be common ground in the work of Bogen (1969); Das, Kirby, and Jarman (1975, 1979), Luria (1966, 1970), and Neisser (1967).

As mentioned in the previous chapter, there has been some work in the areas of cognitive mediation, cognitive style modifiability, and neuropsychology and their practical significance to education. The focus of this study is specifically work in neuropsychology related to the educational relevance of the theory of simultaneous and successive cognitive processing of information (Das, Kirby, & Jarman, 1975, 1979; Kaufman and Kaufman, 1983a). The basis of most work in simultaneous and successive cognitive processing of information is traced through Luria (e.g., 1970). What will first be presented in this chapter is an overview of Luria's clinically derived description of the working brain. Next will be a description of validation studies of the information processing mechanisms and how they relate to important variables. A critique of these studies is then offered. Finally, teaching strategies based on simultaneous and successive cognitive processing of information will be offered along with a critique of the teaching strategy studies. These comments will then be followed by hypotheses tested in this study.

Luria's Model of the Functional Systems of the Brain

Luria (1970) has noted that at least three-fourths of the cerebral cortex has nothing to do with sensory or muscle actions. Because of the large area of the brain devoted to intellectual processes, it is beneficial to look at systems which are responsible for complex behaviors in the human organism. The processes involved with these systems are said to be social in origin (The effects of interaction within the society on basic psychological processes are fully described in Luria, 1976.), highly complex in structure, and involve the elaboration and storage of information and the planning and controlling of behavior. As systems, these functions are not localized in particular cerebral areas but rather are managed by an elaborate apparatus. Another feature of the system is that it is self-regulating. The brain is capable of judging the results of an action in relation to a plan and can end the activity when it arrives at the successful completion of that activity (Luria, 1973).

Based on the syndrome analysis of affected behavior and cognition arising from damaged cortical areas, Luria (1970, 1973) has conceptually organized these systems into three functional blocks or units of the brain and describes how the functional systems work in concert with one another (Luria, 1973). Restak (1982) has pointed out Luria's emphasis on "Holism". Luria is primarily concerned with conceptualizing the brain as a whole functioning unit as opposed to focusing on the localized functioning of a particular lobe or area as it works in isolation.

Luria (1970, 1973) describes the first unit or Block I as regulating the energy level and tone of the cortex. This system gives a stable basis for the organization of various processes and is associated with the activating reticular formation. This block or unit maintains the cortical tone and waking state of the organism and regulates these states in accordance with the actual demands confronting the organism (Luria, 1973).

Block II describes the posterior portion of the neocortex where the analysis, coding, and storage of information takes place. Registration from optic, acoustic, cutaneous, and kinesthetic sources takes place here. The block has a hierarchical organization for dealing with the sensory registration of incoming information. In what Luria (1970) labels the primary zone, information is sorted and recorded. In the secondary zone, information is further organized and coded. Finally, in the tertiary zone, data from the different sources can overlap and combine to set the groundwork for the organization of behavior. Luria (1970) has called attention to the zones in this block because damage to the respective zones manifests itself in differing ways. For example, if there is injury to the primary zone, there may be a sensory deficit without any impact on complex behavior. If damage occurs in the secondary zone, the analysis of sensory stimuli will be affected. Damage to the tertiary zone makes behavior reliant on multisensory input difficult. An example of this is the ability to orient oneself in space. This proves very difficult if damage to the brain has extended to the tertiary zone. Any situation requiring the person to organize input into simultaneous matrices as grammatic logic, language structure, or complex operations with numerals would be affected. In general, the principle role of the tertiary zone is connected with spatial organization of discrete impulses, that is, converting successive stimuli into simultaneously processed groups (Luria, 1973).

The final unit, Block III, is associated with the frontal lobes of the brain. This area is where intentions and programs for behavior are formed. Block III aids in regulation of attention and concentration and, as no motor functions are located here, the processes relate more to sensation, movement, perception, and speech. Luria (1973) summarized the workings of this third cerebral block as follows:

> Man not only reacts passively to incoming information but creates intentions, forms plans and programmes of his actions, inspects their performance, and regulates his behavior so that it conforms to these plans and programmes; finally, he verifies his conscious activity, comparing the effects of his actions with the original intentions and correcting any mistakes he has made (pp. 79-80).

The type of information processing associated with Block III is successive synthesis or the sequential processing of information (Luria & Simernitskaya, 1977). Fostering the conscious use of Block III would be one of the manners of fostering covert self-control as mentioned in relation to cognitive behavior modification.

Luria's (e.g., 1966, 1970, 1973) observations are not in direct conflict with the neuropsychologists such as Sperry (1964) and others interested in the functions of the left versus right hemispheres of the brain (e.g., Ornstein, 1972; Witelson, 1977b). Luria and Simernitskaya (1977) identify functions as perception, language, and memory as requiring the efforts of both hemispheres of the brain. These authors view each hemisphere as having a variety of hierarchically organized information processing systems. In "normal" right handed individuals, the "dominant" (left-brain) hemisphere is seen by Luria and Simernitskaya (1977) to manage the conscious logical processes as language which govern voluntary behavior. The "nondominant" (right-brain) hemisphere is seen to be the site of subconscious, automatic processing not normally under voluntary control. The unique feature of the basis of the simultaneous-successive information processing model is its relation to the anterior versus posterior versus subcortical areas of the brain. White (1965, 1970) has noted the ambimodal sensory capabilities in children during the "five-to-seven shift" which is directly comparable to Luria's (1966, 1973) notions of the functions of the tertiary zones in Block II. Kinsborne (1968) notes Luria's (1966a, 1966b) descriptions of the workings of the frontal lobes (Block III) as being unequalled in adding to our understanding of their complex workings.

In summarizing the work of Luria and others who have developed complimentary models of information processing, Wittrock (1980) notes that:

> Much of the utility of the models derives from the information they provide about the processes used by learners, as different from the abilities of the learners. Some of the models of intellectual ability offer little understanding of the ways information is organized, coded, transformed, and stored. Process-oriented models, such as those of cortical information processing systems, providemore useful information for the design of instruction appropriate for the cognitive strategies and styles of learners (p. 394).

Kinsborne (1968) has critiqued two of Luria's (1966a, 1966b) publications and found some of Luria's ideas weakened by uncertainties seen in most current work taking place in neuropsychology. Kinsborne sees neuropsychologists as overemphasizing expected defects related to isolated cerebral lesions while possibly overlooking other aspects of cognitive functioning which might be affected as well. Still, Kinsborne (1968) sees Luria's (1966a, 1966b) work retaining outstanding significance but prone to quite another limitation--did Luria appropriately analyze disordered behavior and look for problems in physiologically valid processes or has he spoken to man-made abstractions alone? For example, is a failure in "simultaneous synthesis" a consequence of faulty integration of individually perceived stimuli or is the failure of integration a secondary phenomenon (Kinsborne, 1968)?

The primacy of Luria's (1966a, 1966b) observations which describe the modes of information processing in humans cannot be answered directly from his work in syndrome analysis. However, the notions of simultaneous and successive information processing have come under study to determine the validity of this alternative model of cognitive abilities. The validation of the model has been principally achieved through statistical verification using factor analysis.

The Simultaneous-Successive Processing Model

The model of simultaneous-successive information processing developed by Das, Kirby, and Jarman (1975) stems directly from the work of Luria (1966). Luria (1966) attributes much of his work to hypotheses generated by Sechonov, Vygotsky, and the work of Lashley and Hughlings Jackson. Das, Kirby, and Jarman (1975) view information integration and processing as having four basic units consisting of an input, a sensory register, a central processing unit, and a unit for output.

Das, Kirby, and Jarman (1975) explain that a stimulus may be presented to any one of the sensory receptors and, if processed within the tertiary zones, can transfer that information to any one of the sensory modalities. The input stimuli can be presented in a parallel (simultaneous) or serial (successive) manner. The stimulus is then registered by the sensory register and once registered is passed on for central processing (cf. Norman, 1976). Das, Kirby, and Jarman (1975) cite evidence that the sensory register works in parallel and is then "read out" serially into what is termed a central processing unit. This unit has three major components: that component which processes separate information into simultaneous groups, that component which processes discrete information into temporally organized successive series, and the decision-making and planning component which uses the information supplied by the others. Das, Kirby, and Jarman (1975, 1979) hypothesize that these components are not affected by the type of sensory input. For example, visual forms can be processed successively and auditory information can be processed simultaneously. The model assumes both modes of processing are available to the individual. The selection of either or both modes for use depends on habitual modes determined by sociocultural experiences, genetic factors, and the actual demands of the task. The final component of the central processing unit relates to "thinking" in that coded information is used to determine the best possible plan of action for an activity. The final unit, the output, determines and organizes performance in light of the requirements of the task.

Das, Kirby, and Jarman (1975, 1979) offer an expanded explanation of what is termed the simultaneous integration of sensory information. Simultaneous processing:

> . . . refers to the synthesis of separate elements into groups, these groups often taking on spatial overtones. The essential nature of this sort of processing is that any portion of the results is at once surveyable without dependence upon its position in the whole. It is hypothesized by Luria that simultaneous syntheses are of the following three varieties. (a) Direct perception: The process of perception is such that the organism is selectively attentive to the stimulus input in the brain. According to Luria, this type of formation is primarily spatial, even in the case of the acoustic analyzer. (b) Mnestic processes: This refers to the organization of stimulus traces from earlier experience. Examples of this type of integration are the construction of the gestalt of a visual image by the subject when portions of the image are shown consecutively, and the organization of the consecutively presented words into a group on the basis of a criterion. The . . . memory traces can be either short-term or long-term, and the integration of the traces is performed on the basis of criteria which can be specified either by the organism or an external source. (c) The last variety of synthesis is found in complex intellectual processes. In order for the human organism to grasp systems of relationships, it is necessary that the components of the systems be represented simultaneously. In this fashion, the relationships among components can be explored and determined (Das, Kirby, and Jarman, 1979, pp. 49-50.).

Successive information processing is described as follows and:

> . . . refers to processing of information in a serial order. The important distinction between this type of information processing and simultaneous processing is that in successive processing the system is not totally surveyable at any point in time. Rather, a system of cues consecutively activates the components. As in simultaneous processing successive synthesis has three varieties: Perceptual, mnestic, and complex intellectual. According to Luria, the most obvious example of the last variety ofsuccessive processing is human speech. The structure of grammar is such that the processing of syntactical components is dependent upon their sequential relationships within sentence structure. Thus, grammatical structures which have to be understood in terms of their relationships are affected by disturbance of simultaneous synthesis, whereas sequential structures are affected by successive

synthesis (Das, Kirby, and Jarman, 1979, p. 50).

An example of the interplay between the two modes of processing can be illustrated by a story of a professor who has difficulties remembering telephone numbers. To facilitate recall of the sequentially presented digits, this professor would "graph" the digits, thereby, spatially representing them one against the other as a whole "picture". This is how the memory of the digit series is maintained--as a simultaneous matrix. As the need to recall the digits occurs, the numerals can be recalled by "reading" the numerals on the graph in successive order. If a phone number were provided to him as a graphed representation, it is more than likely that the representation would be incorporated directly without need to serially register that information. The information could still be recalled serially, if need be, based on the demands of the task. Also, considering the way the telephone number was mentally constructed, he would be better able to say the number in reversed form or tell what numeral was in a particular position in the seven than one who constructed the number as a series chained one with the other. Such a representation would require going through the series and counting as each numeral was encountered to satisfy the requirements of the task.

Validation Studies

Operationally Defining the Processes

A variety of studies (e.g., Cummins & Das, 1978; Das, 1973a; Das, Kirby, & Jarman, 1975; Kaufman, Kaufman, Kamphaus, & Naglieri, 1982) have been conducted attempting to operationalize the notions of simultaneous and successive information processing using confirmatory factor analysis to validate that these modes of information processing were used to perform a variety of tasks. A battery of tests has emerged for the experimental study of the simultaneous and successive processing of information which is primarily used by Das and his followers. What has generally been found in these studies is the presence of simultaneous synthesis, successive synthesis, and, on occasion, a speed dimension in the performance of persons on these tasks. A listing of these measures is offered to simplify the reporting of the results of studies later. When factor scores are listed in association with particular tests, they are reflecting commonality with other measures of a particular cognitive process.

Tests of Simultaneous Processing. Raven's Coloured Progressive Matrices (Raven, 1956) has been found to be related to simultaneous processing (Das, 1973a; Jarman, 1978; Kirby, 1976; Kirby & Das, 1978; Krywaniuk, 1974; Leong, 1974 ;Molloy, 1973; and Williams, 1976) and to be negatively related to successive processing (Jarman, 1975). Factor loadings in these studies have ranged from .600 to .943 in principal components analysis. A negative loading of .873 with other assumed measures of simultaneous processing was obtained by Kaufman (1978) on the Raven's matrices for students in the fourth grade.

Graham and Kendall's Memory-For-Designs (1960) has been found to be a stable measure of simultaneous processing (Das, 1973a; Jarman, 1975, 1978; Kaufman, 1978; Kirby, 1976; Krywaniuk, 1974; and Leong, 1974). This measure is scored by errors so factor loadings take on negative values. Factor loadings have ranged from -.583 to -.909 in the citations above except for Kirby's (1976) study of grade four males and females (.810 and .793, respectively) and an obtained positive factor loading by Kaufman (1978).

Simultaneous processing has been found to be related to performance on the Figure Copying Test (Ilg and Ames, 1964) (Das, 1973a, Jarman, 1975, 1978, Kirby, 1976, Krywaniuk, 1974, and Williams, 1976). Factor loadings of this measure have ranged from .629 to .866 for the studies cited above.

The final measure finding common use as tapping simultaneous information processing is Cross-Modal coding (Birch and Belmont, 1964). Das (1973a), Krywaniuk (1974), Leong (1974), and Molloy (1973) have reported factor loadings for this measure ranging from .420 to .800. These data, as secured in their respective research designs, have been interpreted as representing the use of simultaneous cognitive processing of information.

Tests of Successive Processing. Four measures have had recurring use as measures of successive cognitive processing of information. Serial Recall (Orn, 1970) has been incorporated into studies (Jarman, 1975, 1978, Kaufman, 1977, Kirby, 1976, Krywaniuk, 1974, Leong, 1974, and Williams, 1976). Successive factor loadings have ranged from .560 to .951 and a successive cum speed factor loading of .731 was obtained by Jarman (1975) in normal IQ males in the fourth grade.

A second measure of successive processing is Free Recall which is a revised scoring system for Serial Recall (Orn, 1970). Successful performance on Free Recall does not include proper sequence--only proper content. Successive processing factor loadings have ranged from

.852 to .955 in studies by Molloy (1973), Krywaniuk (1974), Williams (1976), and Kaufman (1977).

Digit Span Forward is a portion of the well known subtest from the <u>Wechsler Intelligence Scale for Children-Revised</u> (Wechsler, 1974). Factor loadings for the successive factor have ranged from .594 to .811 in studies by Molloy (1973), Kirby (1976), Kaufman (1977), and Jarman (1978).

Visual Short Term Memory (Das, Kirby, & Jarman, 1979) appears to be related to some of Luria's (1973) interpretations of successive processing and has been used by Das (1973), Molloy (1973), Krywaniuk (1974), Leong (1974), Jarman (1975), Kirby (1976), and Jarman (1978) in their studies contrasting simultaneous versus successive information processing. Factor loadings on the successive dimension have ranged from .601 to .977, and Molloy (1973) and Krywaniuk (1974) have found this measure negatively related to what was termed speed of processing.

<u>Tests of Speed</u>. Speed of processing has only emerged as a unique factor in isolated studies. The measures of speed of processing have been Stroops's color naming and word naming tests (1935). Molloy (1973), Krywaniuk (1974), and Kirby (1976) have found speed to be a unique factor with loadings ranging from .573 to .916 for these measures. The color naming and word naming tests were introduced to better explain the role of speed in performance of children on the other tasks when speed appeared to confound the interpretability of other factor loadings with the successive and simultaneous dimensions.

Das, Kirby, and Jarman (1979) can be consulted for an expanded review of all the reported findings for measures of simultaneous and successive cognitive processing and speed of responding. Measures have been added or subtracted from some studies to be noted later which attempt to validate the existence of simultaneous-successive cognitive processes across a variety of populations and tasks. To avoid confusion, the measures cited as tapping simultaneous and successive cognitive processing and speed of processing will be termed the "Das Battery" to simplify the reporting of results of investigations.

Simultaneous and Successive Cognitive Processing and Planning

There has been an attempt to introduce the planning dimension--the decision-making component--of Luria and Das's model to empirical investigation. Ashman and Das (1980) attempted to describe planning factors in relation to simultaneous and successive processing and to distinguish tasks clearly measuring planning while replicating the emergence of the simultaneous and successive cognitive processes in adolescents. Normal IQ eighth grade students were administered the Das Battery plus a visual search test, a trail-making test, a verbal fluency test, and a planned composition exercise as measures of planning. Their results indicated that planning is orthogonal to the cognitive processing coding factors as predicted by Das's model. The construct validity of the planning tasks has not been fully ascertained. Still, there appears to be some credibility in the model based on the interrelationships of the hypothesized components.

Cognitive Processing and Psycholinguistic Abilities

Cummins and Das (1978) sought to relate the simultaneous and successive modes of information processing to performance on linguistic tasks as demonstrated in word association, ambiguities, and class inclusion tasks. Grade three students of average IQ were used as subjects to see if there was a predicted relationship between successive synthesis and performance on the linguistic tasks (hypothesized to require the analysis of the sequential structure of sentences) and if simultaneous synthesis was related to linguistic tasks requiring the grasping of quasi-spacial concepts. Such would be predicted by Luria (1975) and Jakobson (1971).

To test the predicted relationships, Ervin's (1961) Word Association Test was employed as it was predicted that paradigmatic associations are based in simultaneous processing. That is, children with high capabilities in simultaneous processing should do better on such tasks as compared to those less able in the processes. Assessing sensitivity to ambiguities (Kessel, 1970) was another manner of investigating the relationship of simultaneous-successive cognitive processing and psycholinguistic processes by measuring how sensitive a child is to lexical, surface structure, and underlying structure meanings. Evidence cited indicated that the analysis of sequential patterns in surface and underlying structure would require successive processing skills since one is attending to nominative rather than predictive elements of a sentence. The class inclusion tasks used for this study were based on the work of Jean Piaget and were in two parts. Part one dealt with accurately responding to relationships between a class and subclass and the second dealt with justifying responses made relative to the perceived relationships. Both simultaneous and successive cognitive processing were predicted to be required for successful performance here.

The results were analyzed and interpreted to be that simultaneous processing related to class inclusion and word association tasks as predicted. Also, there was a positive relationship between simultaneous processing and lexical ambiguities with a corresponding negative relationship with successive processing in a principal components analysis. When subjects were blocked as high simultaneous-high successive, high simultaneous-low successive, low simultaneous-high successive, and low simultaneous-low successive and the scores from dependent measures submitted to ANOVA, the following results were obtained: simultaneous processing was significantly related to understanding lexical ambiguities and successive processing is related to surface structure and underlying structure ambiguities in sentences. These findings led Cummins and Das (1978) to support Das, Kirby, and Jarman (1975) in their contention that simultaneous and successive synthesis are processing dimensions rather than abilities such as reasoning and memory. Also, though support is not unequivocal, simultaneous and successive processing appear to be related to linguistic processes in a manner predicted by cited elements of Luria's basic model of the functional systems of the brain.

The Cognitive Processes and Illusory Phenomena

Two studies have addressed the relationship between simultaneous and successive information processing and universally experienced illusions. Jarman (1979) sought to relate the processing dimensions to the experience of the Mueller-Lyer illusion. A portion of the Das Battery was utilized to define the processing dimensions allowing subjects to be blocked as high simultaneous-high successive, high simultaneous-low successive, low simultaneous-high successive, and low simultaneous-low successive. The four groups were presented sets of the illusion either as whole forms or as parts of the forms thus establishing a 2 X 2 X 2 factorial design to measure the experience of the illusory effects relative to simultaneous and successive processing skills of the subjects against the manner in which the illusion was displayed.

The obtained results showed a significant interaction between simultaneous processing and the manner by which the illusion was presented; i.e., ability differences in simultaneous synthesis were related to the degree of illusion for both whole and partial presentations of the figures in the illusion. Apparently, if one is able in simultaneous cognitive processing, one will experience a mild illusory effect. If the whole illusion is presented, and one is more able in successive processing, this aided in reducing the illusory effects. However, if the illusion is shown in partial form, highly able successive processing skills actually caused larger illusory effects. Therefore, it was claimed that the processing dimensions were related to the experience of a very common illusion.

Cummins (1976) sought to relate simultaneous and successive cognitive processing to fixation and extinction in the Uznadze (1966) illusion in fifty-three grade ten students. Using his own measures of simultaneous and successive synthesis, Cummins (1976) found no relationship between the information processing modes and fixation with this haptic illusion. He attributed such results to the illusion being related to the "first plain of human behavior" (Uznadze, 1966) which roughly corresponds to Pavlov's first signal system in the classical conditioning paradigm. That is, the experience of the haptic illusion is more related to simple stimulus bonds than to higher-order information processing abilities. Extinction of the illusory effects was another matter. Cummins (1976) found that the speed of extinction was related to simultaneous synthesis which is essential in all tasks where interrelationships of different aspects of situations must be understood. In a manner of speaking, for this illusion, simultaneous processing frees one from the sensory input which could continue the sensation of the illusion more efficiently than can successive processing capabilities.

Within the limitations of Cummins's (1976) and Jarman's (1979) work, one can surmise that the dimensions of simultaneous and successive information processing may relate to the experience or the extinction of what could be termed universal illusions. The way in which one processes the incoming illusory input or the manner in which it is presented dictates to some degree how strong or lasting the illusory effects might be. The studies also allow some interpretation that the processing dimensions are divorced from very simple "automatic" learning as they are from complex planning as suggested by Ashman and Das (1980).

The Cognitive Processes and Academic Performance in Children

A number of studies can be cited to explore the role of simultaneous and successive information processing in the academic performance of children. It appears that the processing dimensions, and the model itself, may be relevant in how academic difficulties are viewed in children. Some credence is given to the notion that it may be more fruitful to view the performance of a child on a task by a process-oriented construct as the simultaneous and successive processing model rather than as an effect of an ability.

The Relationship of the Cognitive Processes to Achievement. As Das, Kirby, and Jarman (1979) have commented, though measures of intelligence have been shown to predict school achievement, there has been a lack of theory relating intelligence measures to achievement measures. Therefore, one cannot be certain how a general ability manifests itself in school performance nor does one know why intelligence predicts achievement. More importantly, one does not know what to do when low achievement is predicted.

Das, Kirby, and Jarman (1979) give two reasons why achievement should be viewed in light of the simultaneous and successive cognitive processing model. First, the coding processes may be important individual difference variables that may interact with educational treatments. Such an orientation is seen as important by Cronbach (1957, 1975) in his Aptitude X Treatment Interaction (ATI) model. Second, such an information processing model allows for the interpretation of correlations with achievement with a rational basis for the remediation of low achievement.

Krywaniuk (1974) studied fifty-six high achievers and fifty-six low achievers (falling respectively in the upper or lower third of a distribution of scores from measures of school work and teachers' ratings) to determine if there were processing differences between the groups in the study. All students were in the third grade. When the Das Battery was analyzed for the principal components, factors interpreted as successive processing, simultaneous processing, and speed emerged. When achievement measures were added, a verbal-educational factor emerged. For the high achieving group, some of the achievement measures clustered with the simultaneous factor which was not the case for the low achieving group. It appeared to Krywaniuk (1974) that the two groups may process information differently in that the success of high achievers was related to their employing the processes more appropriately in relation to the demands of a given task. No clear statement could be made of the low achievement group in this regard though their performance on a reading vocabulary test indicated the application of an analytic (successive) rather than global (simultaneous) approach to reading tasks. Sprecht (1976) has found math achievement best predicted by measures in the Das Battery assumed to measure simultaneous processing and speed of processing in high school students. Krywaniuk (1974) found arithmetic to be more related to the simultaneous processing dimension for the low achieving group of this study than for the high achieving group.

Kirby and Das (1977) took a different approach to the problem of relating simultaneous and successive information processing to achievement; specifically reading achievement. They hypothesized that complex achievement tasks would require adequate levels of both forms of information processing. They wanted to see if those who were high in both types of processing had comparable levels of achievement to those low in any one or both of the processing dimensions. To test this hypothesis, 120 fourth grade students were blocked into high or low processing groups using median split procedures. A 2 X 2 factorial design was created with four groups blocked as high simultaneous-high successive, high simultaneous-low successive, low simultaneous-high successive, or low simultaneous-low successive processing skills. When factors were first analyzed with scores on the Gates-MacGinite Reading Test, the Lorge-Thorndike IQ test, and measures from the Das Battery, achievement scores and IQ scores showed that school achievement variables were related to both simultaneous and successive cognitive processing. When the scores were analyzed in blocked groups, the main effects for simultaneous and successive processing were significant. That is, the high-high group performed consistently best in reading and the low-low group performed consistently worse while groups low in either form of processing were similar and intermediate in their performance. Kirby and Das (1977) also found that a significant proportion of variance of the achievement measures can be predicted by the information processing variables and no one processing mode was more related than the other to achievement. Basically, high achievement seems to be associated with high levels of both forms of processing.

Cummins and Das (1977) employed a similar design to investigate the relationship between simultaneous and successive processing and reading achievement. As they summarized in their article:

> . . . among children who are likely to experience difficulties in reading, competence in successive processing is strongly related to school achievement. However, among normal readers at more advanced levels of reading skills, simultaneous processing is equally, if not more, important in the reading process (p. 250).

In this investigation, Cummins and Das (1977) wished to look at decoding and comprehension skills as they related to the information processing variables. A 2 X 2 ANOVA showed significant main effects for simultaneous processing in both decoding and comprehension. There was no interaction. Also, simultaneous factor scores correlated significantly with decoding and comprehension performance for sixty grade three students of the study. Humphreys (1978) has criticized the ANOVA designs of both Kirby and Das (1977) and Cummins and Das (1977) when a correlational design would have been more appropriate. Thereby, it could have been determined if a significant proportion of variance in achievement was associated with information processing skills.

In a more recent investigation, Leong (1980) sought to relate the processing variables to fifty-eight "retarded" readers, thirty-eight below-average readers, and fifty-eight above-average readers. The Das Battery defined the cognitive processes along with the use of the Auditory Sequential Memory subtest from the Illinois Test of Psycholinguistic Abilities (ITPA) (Kirk, McCarthy, & Kirk, 1968) as a measure of successive information processing. Students were matched by chronological age and Lorge-Thorndike IQ scores. The study was in two parts. In the first part, students blocked as "retarded" or above-average readers (as defined by the Gates-MacGinite Reading Tests) were compared on the measures of the coding processes. It was found that the "retarded" readers scored significantly lower on all of the cognitive processing measures except for Memory-For-Designs. Similar factor loadings were obtained for measures in the Das Battery between the "normal" and "retarded" readers though there was a shift in the vector space in factor analysis between the groups in both Auditory-Visual Coding and Visual Short-Term Memory which appeared to form a speed and visual perceptual factor. Therefore, Leong (1980) concluded that "retarded" readers show different cognitive patterns in comparison to their CA and IQ matched counterparts.

In the second part of his study, Leong (1980) compared below-average readers and above-average readers as defined by their scores on the Gates-McKillop Oral Reading Test and Schonell Word Recognition Test. There was a significant difference in age and IQ for these groups. There was no significant difference on measures of simultaneous and successive processing. Also, the cognitive processes emerged in a principal components analysis of the data. To see how the below-average and above-average readers differed, individual factor scores were calculated. After removing covariance associated with differences in magnitudes between variables in the readers, it was shown the below-average readers lagged behind the above-average readers in both processing dimensions--especially in successive processing. Leong (1980) viewed the battery of tasks to be effective in differentiating "retarded" readers from their controls and below-average readers from above-average readers. The process orientation was suggested to give more insight into the childrens' performance than a "level-of- performance" comparison. Leong (1980) states:

> . . . the Luria-Das paradigm provides the framework that retarded and below-average readers are inefficient in

> acquiring necessary antecedent skills rather than lack the cognitive competence for their successful performance (p. 115).

It would appear that such an orientation could be warranted but not without considering the work of Hunt and Randhawa (1983).

Hunt and Randhawa (1983) tested 165 grade four and five children (mean chronological age was 130 months) with numerous tests of simultaneous and successive processing and tests of sustained attention. The Gapadol Reading Test and tests of math and spelling developed by the Australian Council for Educational Research and New South Wales Department of Education were administered to these youth. Hunt and Randhawa (1983) found that children who had high mathematics scores had the high scores in both successive and simultaneous information processing tests. Children scoring low in mathematics had low scores on measures of simultaneous or successive information processing. Students scoring high on one information processing variable yet low on the other had intermediate mathematics scores. The results on reading and spelling were different from the trends shown in mathematics. The introduction of measures of sustained attention influenced the interpretation of outcomes in reading and spelling which were quite different that obtained in Cummins and Das (1977) and Kirby and Das (1977). It appeared to Hunt and Randhawa (1983) that if students score high on tests of both simultaneous and successive processing and have high scores on measures of sustained attention, then students obtain high scores in reading. If students score low on measures of either information processing dimension, whether or not they score low or high on reading has to do with whether or not they scored low or high on sustained attention. The same results held true for spelling. As a consequence, one must be mindful that the relationship between reading and spelling and measures of simultaneous and successive information processing could be influenced by other factors which have not been controlled.

The Relation of the Cognitive Processes to Grade Level. Das and Molloy (1975) attempted to extend the simultaneous and successive cognitive processing model to describe viable individual difference variables and to clarify the nature of the tasks in the Das battery in the context of intelligence and achievement at two grade levels. Their subject sample consisted of sixty first and sixty fourth grade students. The first grade students of the sample were selected on the basis of having scored below the fiftieth percentile rank on the Metropolitan Achievement Test while having scored within the "dull normal" range on the Lorge-Thorndike Verbal IQ scale. Tests from the Das Battery were intercorrelated, and the recurrence of the coding processes was found for both groups in that the factors were identifiable as simultaneous processing, successive processing, and speed. Cross-Modal Coding was not included in the Das Battery for the first graders as it proved too difficult for them. Some of the findings were that Figure-Copying was shown to be related more to simultaneous processing for the fourth grade students yet related more to successive processing for the first grade students. This led Das and Molloy (1975) to suspect that there may be "strategy ambivalence" in young children. The results of this comparison and the principal components analysis led Das and Molloy (1975) to support the hypothesis that simultaneous and successive processing are appropriate descriptions of individual differences in a number of problem solving situations and offer a better theoretical model of what underlies success on cognitive tasks than hierarchical models encompassing reasoning and memory as offered by Jensen (1970). Similar support for the viability of simultaneous and successive cognitive processing as important individual difference variables have been found by Jarman and Krywaniuk (1978) for grade three children. Ashman and Das (1980) found the processes to describe performance in eighth grade students as well. Vernon, Ryba, and Lang (1978) could not easily identify the variables in college students in an attempt to replicate Das's original findings.

The Relation of the Cognitive Processes to IQ. Jarman and Das (1977) questioned whether differences in IQ levels can be characterized by the differential use of simultaneous and successive synthesis for particular tasks. To this end, grade four students were blocked into three IQ groups on obtained scores from the Lorge-Thorndike. The IQ ranges from the Lorge-Thorndike Verbal IQ's were 71-90, 91-110, and 111-130. The sample consisted of males only. To insure homogeneity within the groups, there was an upper and lower limit established within which the Lorge-Thorndike Performance IQ score could fall for each group. Simultaneous and successive cognitive processing were defined by the Das Battery.

Jarman and Das (1977) found that the means for the tasks increased as IQ scores increased. The scores for the groups were subjected to one-way fixed effects MANOVA and there were significant differences among the groups. They also found that simultaneous processing was highly stable for each group. As IQ scores increased, the facility in performance IQ increased and the role of speed as a separate factor became less important. Successive processing was found as stable across all groups, though some of the successive tasks bore some relationship to speed of processing. The general trend was said to be that successive information processing and speed appear for the low and normal IQ groups. Still, both of the coding processes were identifiable and no high degree of specialization of information processing was characteristic of a particular intelligence group.

The Relation of the Cognitive Processes to the Mildly Educationally Handicapped. The mildly educationally handicapped are defined here as the groups labelled as having specific learning disabilities and being educable mentally handicapped. Some studies have directly investigated aspects of the simultaneous and successive cognitive processes and how they relate to these students. Some mention has already been made of those with low IQ scores (Jarman & Das, 1977) and "retarded" reading ability (Leong, 1980). The following studies relate the coding processes to the learning handicapped in a more specific manner.

In one of Das's (1972) original studies of the coding processes used by the retarded and nonretarded, the results led him to suggest that the educable mentally retarded use simultaneous and successive processing in a different manner than do normal students. He had matched his subjects by mental age and arrived at this assumption based on disparate loadings between the groups on some of the measures which began the Das Battery. Jarman (1978), however, reexamined Das's (1972) assumptions by using a more refined test battery and found his sixty-seven educable mentally handicapped students under study to use the same fundamental cognitive processes as the nonretarded for particular tasks. The need was then established to investigate the uses of the processes in tasks requiring effective strategic behavior. This particularly related to the school-learning tasks common to retarded children (Jarman, 1978).

Das and Cummins (1978) sought to further investigate the coding processes and the extent to which they were related to academic achievement and Wechsler Intelligence Scale for Children-Revised (WISC-R) (Wechsler, 1974) performance and verbal IQ scores in mentally handicapped adolescents. The Wide Range Achievement Test (WRAT) along with the Schonell Silent Reading Test were used as measures of achievement. The coding processes were defined by Raven's Progressive Matrices and Figure-Copying for simultaneous processing and Serial Recall and Digit Span Forward for successive processing. The mean WRAT scores given in grade equivalents were 4.6 for "Spelling", 3.9 for "Arithmetic", and 4.9 for "Reading". The mean silent reading score from the Schonell was 3.3. The results showed that simultaneous processing was significantly correlated to arithmetic and that successive processing was significantly related to spelling and negatively related to WISC-R performance IQ. Das and Cummins (1978) speculated that simultaneous processing is especially important in developing advanced levels of comprehension skills while successive processing may be essential for the development of elementary decoding skills.

To further investigate this line of thought, Cummins and Das

(1980) studied ninety-five mentally handicapped students (WISC-R IQ = 50-80) whose mean age was thirteen years and nine months of age. Two areas of investigation were addressed. First, would A. S. Kaufman's (1975) factors of verbal comprehension, perceptual organization, and freedom from distractibility from the WISC-R emerge for mentally handicapped students and, secondly, would the following hypotheses be confirmed: that simultaneous processing would relate to Kaufman's (1975) perceptual organization factor from the WISC-R and "Arithmetic" on the WRAT; that successive processing would relate to WRAT "Spelling" and "Reading" scores; that the WISC-R verbal comprehension factor would relate to all WRAT subtests; and that the WISC-R freedom from distractibility score would relate to "Arithmetic" from the WRAT. The results showed simultaneous processing related significantly to perceptual organization ($p < .01$), freedom from distractibility ($p < .05$), and WRAT "Arithmetic" ($p < .01$). Successive processing was only significantly related to verbal comprehension ($p < .01$). Freedom from distractibility was significantly related to "Arithmetic" from the WRAT. What was of interest to Cummins and Das (1978) was that verbal comprehension was unrelated to achievement as measured by the WRAT. Cummins and Das (1980) speculated that the mentally handicapped child may not be applying their verbal abilities to academic tasks although the factor structure of the WISC-R is similar for the mentally handicapped and the sample used to norm the measure. The ways in which the mentally handicapped apply their abilities to literacy-related tasks was hypothesized to differ. It appeared to the authors that poor reading skills of many mentally handicapped children may not be entirely attributable to their low intellectual ability in and of itself. The mentally handicapped childrens' ability to apply their abilities to literacy-related academic tasks may also contribute significantly. The lack of a relationship between the verbal comprehension score and WRAT grade scores is not entirely alarming due to the restricted range of IQ scores (50-80 IQ). However, when one considers that Kaufman's verbal comprehension subtest cluster from the WISC-R provides the most information in discriminating between able and disabled readers in the fourth and sixth grade, and takes second place to freedom from distractibility at the second grade among Kaufman's (1975) three factors (Smith, 1979), the results could be interpreted as quite surprising and Cummins and Das's (1980) conclusions may be warranted. Also, Dickie and Ray (1973) have shown that linguistic support in performing a sorting task aids normal IQ students but does not aid the mentally handicapped. Therefore, the ability to apply skills to tasks may be just as important for mentally handicapped students as any ability-related explanation of their difficulties. These notions are reminiscent of Leong's (1980) contention that ". . . retarded and below-average readers are inefficient in acquiring necessary antecedent skills rather than lack the cognitive competence for their successful performance (p. 115)."

The relationship between simultaneous and successive cognitive processes to learning disabilities has received some research though it is not exhaustive. Indirect evidence of successive processing difficulties being present for this heterogeneous group has been shown in auditory and verbal stimuli retention (Richie & Aten, 1976), temporal sequential memory (Badian, 1977), sequencing activities (Wirtenberg & Faw, 1975), the processing of sequential information

(Leton, 1974; Meier, 1971), and consistency in ordering stimuli (Senf, 1969). Additionally, Eakin and Douglas (1971) found children with reading problems to have difficulties with "automized" tasks which are similar to the Das, Kirby, and Jarman (1979) speed of processing measures. Problems in the planning dimension of the Luria-Das model are suggested by Das, Kirby, and Jarman (1979), Molloy and Das (1980), andWirtenberg and Faw (1975).

Leong (1974) studied fifty-eight children (mean age = 111 months) who were more than two years below grade level in reading with fifty-eight controls matched by Lorge-Thorndike performance IQ scores. Using the Das Battery to define the coding processes, it was found that there was some variability in factor loadings, though the coding processes existed for both groups and they approached the tasks in similar ways. The only measure where this was confounded was the Visual Short Term Memory test which failed to load on successive information processing for the retarded readers. Das, Kirby, and Jarman (1979) provide two possible reasons for such results. First, the Visual Short Term Memory measure may have really been tapping speed for the retarded readers (Eakin & Douglas, 1971, noted problems in "automized" tasks for such subjects.) or, secondly, the retarded readers may have attempted to use a global strategy on the tasks rather than a sequential scanning strategy. Witelson (1977a) has noted how dyslexics approach tasks as though they possess two right hemispheres and no left, which is consistent with the latter hypothesis. In general, Leong (1974) demonstrated that the retarded readers have difficulties on all of the coding tasks even though matched on nonverbal IQ scores with controls. Das, Kirby, and Jarman (1979) attribute such findings to the inefficient strategies used by retarded readers in approaching tasks.

Further light can be shed on those youth experiencing reading disabilities in a dissertation by Williams (1976) subsequently published along with Leong's work in Das, Leong, and Williams (1978). Williams (1976) questioned whether or not the disabled students'cognitive processes could be understood in terms of the simultaneous and successive processing model. To this end, students rated as being hyperactive and hypoactive were compared with children exhibiting normal levels of behavior on the processing dimensions through the use of the Das Battery. Subjects in this sample were roughly one year older than those in Leong's (1974) investigation. No differences were found in the measures of simultaneous and successive cognitive processing between the three learning disabilities groups so scores were pooled and subjected to principal components analysis. It was found that the same patterns of simultaneous and successive synthesis and speed of processing existed between the hypo- and hyperactve groups though scores on the measures were all below those of the controls save for their performance on Color Naming. Based on Leong's (1974) work and William's (1976) work, it appears that simultaneous and successive cognitive processing may be relevant dimensions upon which to view the information processing capabilities and educational disabilities of the mildly educationally handicapped.

Critique

The main difficulty with these studies is that they are only correlational in nature or non-treatment ANOVA designs. Factor analysis was used extensively to confirm the processing dimensions across numerous populations in relation to a number of variables. Though there may be plenty of evidence that the processing dimensions may be related to educational attainments and handicaps, there is little evidence that there is a cause and effect relationship between the processing dimensions and what is best done for learners in the schools. Further, relating the processing dimensions to "reading", "spelling", and "arithmetic" achievement is rather confusing given that the focus is on the processes used by learners. There are so many ways to teach these academic areas (see Aaron & Poostay, 1982 and Reisman, 1982 for examples). It seems as though the processes used while reading, spelling, and calculating arithmetic problems would be more interesting to study as they relate to strengths and weaknesses in the processing dimensions. Conceptually, this would seem to be a more fruitful avenue than determining correlations with grade equivalent or standard scores from achievement tests.

Das, Kirby, and Jarman (1979) and Kaufman and Kaufman (1983) have concluded that these information processing dimensions provide us with vehicles for influencing the educational achievement of children. However, nothing in this research proves this. Rather, the studies demonstrate some confirmation of the Luria-Das model but with measures of the authors' choosing using factor labels developed by the authors. As Hunt and Randhawa's (1983) study showed, the introduction of a new variable (in this case, sustained attention) can alter the results in demonstrating the relationship between simultaneous and successive information processing and achievement. Though there has been some cross-validation of the "existence" of simultaneous and successive (sequential) cognitive processing with novel tasks (e.g., Naglieri, Kaufman, & Kamphaus, 1981), this body of research presented thus far simply shows that there is another way to conceptualize human abilities, that the abilities described seem to relate to what is known of brain-behavior relationships in the Luria school of thought; and these abilities seem to be related and important in the academic achievement of children. What has not been shown in this body of research is the relationship between simultaneous and successive (sequential) information processing and new learning.

Teaching Strategies Based on the Model of Simultaneous and Successive Processing

Studies have been designed to use specific remediation procedures for the amelioration of academic deficits based on the simultaneous-successive information processing model or designed to teach information based on one processing mechanism or other. The results have been encouraging.

Kaufman (1978), sought to determine if the coding processes could be taught to thirty-four average and thirty-four below average fourth grade achievers. The coding processes were defined by Raven's (1960) Progressive Matrices and Memory-For-Designs for simultaneous processing and Digit Span Forward, Color Naming and Serial Recall for successive information processing. Included as dependent measures were the Schonell Graded Reading Word List and the Bender Visual Motor Gestalt Test. The intervention was conducted over a seventeen week period, thirty-five minutes per week, offering each subject ten hours of training. The study was conducted to determine whether it was feasible to train in the use of successive (where necessary) and simultaneous strategies by means of comprehensive and directive verbalizations.

A variety of media were used for the training. These media included puzzles, matrices, picture stories, activities requiring the serial recall of pictures, filmstrip viewing, visual discrimination tasks, visual memory tasks, and visualization tasks. Throughout the training, children were encouraged to verbalize strategies and give verbal summaries of previously used strategies. Kaufman (1978) found that the training improved performance on all of the measures of the coding processes but the Raven's matrices. He also found the training to transfer to word attack skills as well as improve performance on the Schonell word list. The implications of the study were stated to be that the training was feasible and was of help to average students. Kaufman and Kaufman (1979) described the students as perceiving the tasks as fun and nonthreatening. Apparently, the coding processes may be aided in a similar fashion as Meichenbaum (1977) and Meichenbaum and Goodman (1971) have demonstrated for training children to control impulsive behavior. Training instituted by Kaufman (1978) can improve performance on academic and nonacademic tasks when the training is specifically related to simultaneous and successive synthesis of information.

Krywaniuk (1974) addressed the facilitation of successive processing in grade three and four children who were of Native Cree extraction. Successive processing was of special interest in this study based on the general need of the sample, i.e., possessing adequate simultaneous processing skills while lacking verbal-successive processing ability. In the remediation program, verbalization was encouraged during the solution and work phases of sequence story boards, the duplication of parquetry designs, the development of grouping strategies in Serial Recall tasks, the application of kinesthetic reinforcement of patterns for the solution of Cross Modal Coding exercises, and the use of matrix serialization to remember successive matrixes. It was found in subsequent statistical analysis that the successive processing training facilitated successive areas of cognition in visual and short-term memory with improvement on a word reading test. Krywaniuk and Das (1976) reported pre- and post-training factor scores from a principal components analysis on the ten cognitive tasks used in Krywaniuk's (1974) study. First, total communality increased from sixty-eight to seventy-four percent indicating the treatment had "reduced the gap" between potential and performance to some degree. Secondly, important shifts in factor loadings were noted. For example, Raven's matrices loaded more on simultaneous processing which was more closely aligned to the nature of the task. Also, Visual Short Term Memory loaded more appropriately on the serial and simultaneous rather than speed and simultaneous dimensions. Search and recall strategies were hypothesized to have eliminated speed as alimiting variable in the childrens' performance. Overall, it was shown that performance was improved in these students as was their application of proper strategies to some tasks.

Gunnison and Kaufman (1982) report two studies employing different reading comprehension strategies for children with high simultaneous processing skills in relation to their successive information processing skills as defined by the mental processing scales of the K-ABC. In the first study described, fourteen children were randomly assigned to either an experimental (processing) treatment group or a traditional treatment group. Students ranged in age from nine years four months to twelve years five months and were matched according to sex, age, SES, and the size of the difference between their sequential and simultaneous scale scores. The training for both groups was for twenty hours over a ten week period of time. The experimental group received individualized instruction to increase overall reading comprehension. As an example of a technique to teach recognizing the main idea and supporting details, the child was to skim a "prechunked" story and use text and pictures to predict what the story was about. The idea was to utilize the child's identified strength in simultaneous processing to teach and practice reading comprehension skills. Using reading comprehension and reading recognition subtests from the Peabody Individual Achievement Test (PIAT) and the Stanford Diagnostic Reading Test (SDRT) as dependent measures, only vocabulary on the SDRT showed a significant pretest to posttest change. In the other study reported by Gunnison and Kaufman (1982), which had as subjects eight children aged nine years eight months to twelve years two months, children with similar processing strengths and weaknesses as children in the first study showed positive significant pretest to posttest increases on the PIAT reading recognition subtest and the SDRT literal comprehension, inferential comprehension, and total comprehension test scores.

Leasak, Hunt and Randhawa (1982) used simultaneous processing training, conducted by classroom teachers for sixteen hours over a sixteen week period of time. The intervention was used on grade four students. The mean age of subjects was 116.9 months and there was a total of forty-eight subjects for the experimental group. The control group had forty-six members with a mean age of 117.2 months. Students were not matched on any variables. The WRAT was used for pretesting and posttesting. There were significant improvements reported in reading and arithmetic but not for spelling. No ANOVA summary table was made available by the authors for inspection.

Hobby (1981) sought to determine the effects of simultaneous and successive word processing strategy training on spelling and reading achievement for learning disabled youth deficient in successive processing. Dependent variables of interest were successive processing, the reading of simulated words (the teaching strategy task), the reading of English words, and the spelling of English and simulated words. Learning disabled students scoring below the twenty-fifth percentile rank on the Visual Aural Digit Span Test (VADS) (Koppitz, 1977) who had been placed in a learning disabilities classroom were selected as subjects. The treatments consisted of teaching successive word processing strategies, simultaneous word processing strategies, and the two in combination in the decoding and reading of simulated words. The study showed the successive processing training to significantly increase reading recognition and spelling of simulated words, and there was also a significant increase in obtained scores from the VADS. There was no significant increase in the number of English words spelled.

Das, Kirby, and Jarman (1979) note that three directions are implicit in incorporating the coding processes into educational design. The first direction to consider is the direct teaching of strategies. The second is to design programs based on processing strengths. The third is to aid children in employing optimal processes for a given task. Though comprehensive remediation systems have yet to be designed based on these three directions and the model from which they were generated, some evidence exists that training in the coding processes, in light of the target task, can meet with some success and significant results. There is also evidence teaching efforts have transferred to the use of improved processes to other tasks.

Critique

What is extremely clear is that the relationship between simultaneous and successive (sequential) information processing and new learning has not been established in any comprehensive way. The information processing based training suggestions in Gunnison, Kaufman, and Kaufman (1982) and Kaufman and Kaufman (1983a, 1983b), while seeming proper in concept, must be viewed as experimental in practice.

Studies which have attempted to demonstrate the effects of training or teaching to simultaneous and successive cognitive processes have numerous problems which must be overcome. Kaufman (1978) and Krywaniuk (1974) focused on successive processing interventions with little concern for simultaneous processing interventions. Further, the interventions are very clinical and would be very difficult to replicate. Gunnison and Kaufman (1982) report studies which only included children with successive processing abilities that were worse than their simultaneous processing abilities which really limits the scope of their study. Further, Gunnison and Kaufman (1982) compared a simultaneous reading comprehension program and a traditional program without describing the traditional program. What if the "traditional" program was an inferior program in the first place? Gunnison and Kaufman (1982) did not show that superior performance was yielded by children with simultaneous processing strengths on the simultaneous reading comprehension approach because of the supposed aptitude by treatment interaction. Hunt and Randhawa's (1983) study showing that sustained attention is associated with how simultaneous and successive processing may be expressed in reading and spelling suggests that at the very least, skills in both simultaneous and successive information processing dimensions must be controlled in order to have meaningful research in this area. Though Hobby (1981) has the most easily replicated experimental procedures with a clear and systematic research design, he too paid no attention to both simultaneous and successive information processing abilities of his subjects when employing a teaching strategy using the information processing mechanisms. Also, Hobby's (1981) simultaneous word processing training does not seem valid and it is curious why children with a weakness in successive information processing would do their best when introduced to a successive information word processing strategy rather than with a simultaneous word processing strategy. Hobby (1981) also only used a subpopulation of learners (the learning disabled) as subjects which limits the generalization power of this study. Much work needs to be done in this area.

Summary

It has been maintained that substantive theories and research in areas such as cognitive psychology and neurology have been blatantly ignored in present conceptualizations of what constitutes intellectual behavior. Cognitive processing models appear to possess some practical and heuristic value in suggesting ways to better align ways in which we teach information to the ways in which that information can or should be processed.

Das, Kirby, and Jarman (1975, 1979) have operationalized the concepts of simultaneous and successive synthesis and have shown them to be important variables of individual differences. These information coding processes have been found to be associated differentially with types of psycholinguistic processes and to the experience and habituation of common illusions. These coding processes have also been suggested to be orthogonal to the planning and organization of behavior as suggested by the Luria-Das model. Simultaneous and successive processes have been shown to be differentially associated with forms of achievement though they appear to both be necessary for high levels of achievement; especially in reading. The processes have been found to be stable characteristics of childrens' performance on tasks across IQ ranges, grades, cultural groups (Das, Kirby, and Jarman, 1979), and groups termed the mildly educationally handicapped. Special problems have been noted for the learning disabled and mentally handicapped in that both score consistently lower than adequate achievers on measures of simultaneous and successive cognitive processing and may have difficulties applying what skills they have to tasks. Preliminary studies have shown that the processes can be taught and aid language deficient children, children with successive processing difficulties, and even average and below-average achievers.

The model of simultaneous and successive information processing appears then to have some validity both from the work of Luria in syndrome analysis and the work of Das and his associates and students through confirmatory factor analysis. The essence of the model has been incorporated into the latest construct of intelligence as defined by an IQ test (Kaufman and Kaufman, 1983b). What is clear is that more research needs to be conducted to test the role of both strengths and weaknesses in simultaneous and successive processing as they interact with simultaneous or successive teaching strategies. Thereby, methodological problems with the studies in the literature can be overcome (e.g., Gunnison & Kaufman, 1972; Hobby, 1981; Kaufman, 1978; Krywaniuk, 1974) and the translation of this theory to educational practice can be better tested.

Hypotheses

Based upon available research on the role of abilities in simultaneous and successive information processing and achievement and the information processing based training which has been conducted, the following research hypotheses were advanced.

Research Hypothesis No. 1:

Children low in successive information processing ability with adequate simultaneous information processing ability will read simulated words best when they are taught to read a set of simulated words with a simultaneous word processing teaching strategy rather than with a successive word processing strategy.

Research Hypothesis No. 2:

Children low in simultaneous information processing ability with adequate successive information processing ability will read simulated words best when taught to read a set of simulated words with a successive word processing strategy rather than with a simultaneous word processing strategy.

Research Hypothesis No. 3:

Children low in successive information processing ability with adequate simultaneous information processing ability will read English words best when they are taught to read a set of simulated words with a simultaneous word processing teaching strategy rather than with a successive word processing strategy.

Research Hypothesis No. 4:

Children low in simultaneous information processing ability with adequate successive information processing ability will read English words best when taught to read a set of simulated words with a successive word processing strategy rather than with a simultaneous word processing strategy.

Research Hypothesis No. 5:

Children low in successive information processing ability with adequate simultaneous information processing ability will spell simulated words best when they are taught to read a set of simulated words with a simultaneous word processing teaching strategy rather than with a successive word processing strategy.

Research Hypothesis No. 6:

Children low in simultaneous information processing ability with adequate successive information processing ability will spell simulated words best when taught to read a set of simulated words with a successive word processing strategy rather than with a simultaneous word processing strategy.

Research Hypothesis No. 7:

Children low in successive information processing ability with adequate simultaneous information processing ability will spell English words best when they are taught to read a set of simulated words with a simultaneous word processing teaching strategy rather than with a successive word processing strategy.

Research Hypothesis No. 8:

Children low in simultaneous information processing ability with adequate successive information processing ability will spell English words best when taught to read a set of simulated words with a successive word processing strategy rather than with a simultaneous word processing strategy.

CHAPTER III

METHOD AND PROCEDURE

Subjects

Students

The subjects of this study were thirty-five second grade public school students from two towns in North Central Oklahoma who had deficiencies in successive information processing with adequate simultaneous processing skills or had deficiencies in simultaneous information processing abilities with adequate successive processing skills. Second grade students were used for three reasons. First, the majority of children this age recognize the letters of the alphabet and are beginning reading as an academic skill. Second, the measures of simultaneous and successive information processing could be applied for this population. Third, one of the major tasks in reading instruction in second grade is having the children master a greater number of words which can be read by sight. Consequently, any benefit from teaching the word processing strategies to these students would serve both the purpose of this study and the duties of the classroom teachers whose students were involved in the study.

The two towns in which students serving as subjects resided had approximate 1980 populations of 2,000 and 3,000. The educational background of town residents could not be determined directly.

However, combined weighted data from the counties in which these towns were located reflected that 31% of residents had less than four years of high school, 29% of residents had four years of high school, 26% of residents had some college, and 15% of residents had college degrees (The Municipal Year Book. New York: International City Management Association, 1984). The percentage of persons having a college background may be slightly inflated as a state university is located in the same county as one of the towns. Wage earners in the towns work in the labor and trades, agriculture, or small businesses. The families of students in the study were generally of lower or middle socio-economic status.

The subjects in the study had a mean age of 8.2 years with the youngest subject being 7.75 years of age and the oldest student being 9.5 years of age. Twenty-two of the thirty-five subjects were female and thirteen were male. One student was black, one student was native American Indian, and one student was of Indic origin. All other subjects were Caucasian. Permission to conduct the study was obtained through the school superintendents and building principals.

Teachers

The teachers who administered the treatments of the study were the regular classroom teachers of the subjects. Each had established a working relationship with subjects for at least 160 days. All teachers were Caucasian and held college degrees and regular certification for elementary education.

A wide range of teaching experience was reflected in the teachers with the minimum experience being seven years and the maximum experience being roughly twenty years. Each of the teachers had taught in the school districts of the subjects at least three years.

The reason students of this study were selected from the two North Central Oklahoma towns was due to the teachers. Prior to approaching any school districts for permission to conduct the study, it was first determined if teachers would be willing to administer the treatments and have the time to fit the treatments into their normal daily schedules. Each of the teachers from the school districts educating the subjects of the study were willing and eager to administer the treatments. No other nearby school districts were available where all teachers of second grade students had the time or desire to teach the word processing strategies. The teachers were not requested or ordered to participate by school officials. This author feared that if persons administering treatments did not freely wish to participate, any negative attitudes about administering the treatments might transfer to or be perceived by the students. Further, treatments might not be administered properly or with any normal teaching enthusiasm. There was also a concern that there might be differences in students from classrooms of teachers who wished to participate and classrooms of teachers who did not wish to participate within a given school district. Obviously, this could confound the results and negatively impact the integrity of the study.

Instrumentation

The assessment instruments in this study were standardized measures used to assess information processing abilities and a fixed list of simulated words and English words closely resembling the simulated words. The word lists were adopted from Hobby (1981) to compare the number of words the children could read and the number of words they could spell after treatments. The word processing treatments were based on the reading of simulated words.

Visual Aural Digit Span Test

The Visual Aural Digit Span Test (Koppitz, 1977) or VADS was used as the measure of successive information processing. The VADS was the last test developed by the late Elizabeth M. Koppitz. The development of the VADS test was a natural outgrowth of Koppitz's clinical experience as a school psychologist. She noted that there were commonalities in the learning problems of young children specific to intersensory integration, and the sequencing, and recall of information. The VADS satisfied a need for an easily administered screening tool to measure these areas of functioning.

The VADS is normed for children five and one-half to twelve years of age. Essentially, the VADS is a sophisticated digit span test. The test involves the seeing and hearing of digit series and the written and vocal recall of the sequentially presented digit series by the examinee. There are four subtests on the VADS. On one subtest (Aural-Oral), children recall a digit series which has been spoken to them by vocally repeating that digit series. On another subtest (Visual-Oral), children recall a digit series which has been shown to them for ten seconds by vocally repeating that digit series. On yet another subtest (Aural-Written), children write down a digit series which they have heard. On the final subtest (Visual-Written), children write down a digit series they have viewed for ten seconds. For each subtest, there are numerous pairs of digit series of the same length and the length of the series increases by one digit as the examinee progresses through each subtest. A subtest is discontinued once the examinee cannot repeat or reproduce either digit series of a particular level. Norms are available for each subtest score and for determining the relative performance in using aural input or visual input and recalling information in written or oral form. Norms are available for intrasensory and intersensory integration of information and for the total test score. The test is scored by awarding one point per digit series recalled until both series of a given level cannot be recalled.

Numerous studies are cited by Koppitz (1977) that relate performance on the VADS to school achievement. In her own study, Koppitz found that scores from the VADS obtained in late kindergarten adequately predicted that children falling below the twenty-fifth percentile on the VADS would be in the lower half of their group on the Comprehensive Test of Basic Skills when in the third grade. Furthermore, children unable to read and write any digits on the VADS in this group at the end of kindergarten tested roughly four grade levels below the average of the group as a whole by the third grade.

Koppitz (1977) states there to be little reason to expect a reading comprehension test to correlate with a test of "perceptual-motor processing, sequencing, and recall" (p. 75). Koppitz (1975) showed the Visual-Oral and Visual-Written subtests to be significantly correlated to the score from the Comprehension section of the Gilmore Oral Reading Test (r = .35 and .25 respectively). Shumar (1976) and Thompson (1976) showed the reading recognition subtest from the Peabody Individual Achievement Test to be related to VADS performance for second-, third-, and fourth-graders and to Reading Vocabulary scores from the California Achievement Test. One interesting research finding was that the VADS scores were significantly related to the Reading score on the WRAT for learning-disabled youngsters yet was not significantly related to the Reading score from the WRAT for average pupils.

Koppitz (1977) states the Visual-Oral, Visual-Written, and Visual Input scores to be most closely related to reading achievement for second- to fifth-grade pupils. The ease of administration, the emphasis on information integration and sequencing, and the similarity between this measure and previously used measures of successive processing (Digit Span Forward from the WISC-R, Wechsler, 1974; the "tapping" recall test of Birch and Belmont, 1964; Auditory Sequential Memory from the ITPA of Kirk, McCarthy, & Kirk, 1968; and another "tapping" recall test by Senf, 1969) led the present author to conclude that the VADS would be a suitable and useful measure of successive information processing abilities of the subjects of the study. Hobby (1981) used the VADS for measuring successive processing skills of learning disabled youth in his study. Similar tests as Auditory Sequential Memory from the ITPA have loadings in the .80s or greater with assumed measures of successive processing in Principal Component Analysis (e. g., Leong, 1980).

Coloured Progressive Matrices

Raven's Coloured Progressive Matrices (1956) was used as the measure of simultaneous information processing. Raven's Coloured Progressive Matrices (Sets A, Ab, B; Raven, 1956) is a test of intellectual reasoning for children aged five to eleven years. The test consists of a test booklet which contains thirty-six matrices or designs from which a part is missing. The examinee is to determine which of the six possible pieces presented below the matrices best belongs in each design. The matrices become increasingly difficult and complex. Das, Kirby, and Jarman (1979) label the matrices appearing in the beginning of the test to measure how accurately an examinee makes visual discriminations while later matrices involve "analogies, permutation, and alternation of pattern, and other logical relations" (p. 209). The test is said to be culturally reduced as little actual knowledge is tested and any reasoning is applied to rather foreign stimuli. There is some teaching before the examinee begins regarding how to take the test. The matrices are presented in a booklet and answers are recorded on an answer sheet by the examinee. Raven (1956) relates that children eight years of age and older can usually be trusted to use the answer sheets correctly but must be watched in small groups to make sure that pages are turned one at a time and no pages are missed. Answers are scored as correct or incorrect.

Raven (1956) asserts that the Coloured Progressive Matrices assess a person's level of intellectual development. Raven reports test-retest reliability to be highest (.80) for children of around 9.5 years of age. Correlations of .65 to .95 are reported with the Terman-Merrill and Crichton Vocabulary Scales. Percentile scores for total scores are reported at half-year intervals from ages five and one-half to eleven. Little information beyond this is provided by Raven (1956). Norms apparently are based on the 291 British children taking the experimental form board of the test which was only rearranged and printed in a booklet to make sets A, Ab, and B.

Robb, Bernardoni, and Johnson (1972) cite correlations between Raven's Matrices and the Stanford-Binet and Wechsler scales to vary from .41 to .86. Correlations cited by Robb, et al., (1972) with academic test scores to be in the .20's and .30's. Test-retest and internal consistency coefficients for children are reported to range from .71 to .88.

Das, Kirby, and Jarman (1979) state the Coloured Progressive Matrices to

> . . . fulfill the requirements for a test of simultaneous processing in that their solution requires the construction of a spatial pattern or scheme. Only after such a scheme has been formed can the option which correctly completes the pattern be chosen (p. 52).

Factor loadings for the Raven's Coloured Progressive Matrices with other assumed measures of simultaneous information processing (Memory-For Designs, Figure Copying Test, Cross-Modal Coding) can be found in Chapter II.

Dependent Measures

Tests of the reading and spelling of words for use in evaluating reading recognition and spelling were adapted directly from Hobby (1981). Hobby constructed two word lists based on the Starlin and Starlin (1972) curriculum ladder. One of the word lists contains fifty simulated words (Appendix A) which was used in the training and for posttesting. The use of simulated words in the word processing teaching strategy was of aid in diminishing the effects of children having been previously exposed to the words and allows for teaching a manner with which to attack basic word forms. A second word list consisted of fifty English words which matched the simulated words on the curriculum ladder steps. The English words were used to determine if there was any transfer of learning from the teaching strategies applied to simulated words to actual words which would be confronted by the student (Appendix A).

In using the curriculum ladder of Starlin and Starlin (1972), it was possible to generate simulated words and real words representative of basic word forms normally encountered in the reading act. That is, all basic short and long vowel sounds in words are represented as are most all digraphs and diphthongs. Omitted are words which represent phonetic irregularities. The simulated words are listed by the basic rule or form they represent in Appendix A. Real words from Appendix A are generated directly from the same basic rule or form. The reading of the words was tested by their proper pronunciation. The spelling of the words was tested by the spelled words matching stimulus words as listed in the Appendix A and Appendix C.

Procedure

Subject Selection

The subjects of this study were second grade public school students who had deficiencies in successive information processing with adequate simultaneous processing skills or had deficiencies in simultaneous information processing abilities with adequate successive processing skills. Second grade students were used for three reasons. First, the majority of children this age recognize the letters of the alphabet and are beginning reading as an academic skill. Second, the measures of simultaneous and successive information processing can be used for this population. Third, one of the major tasks in reading instruction in second grade is having the children master a greater number of words which can be read by sight. Consequently, any benefit from teaching the word processing strategies to these students would serve both the purpose of this study and the duties of the classroom teachers whose students were involved in the study.

All second grade students from two school districts in North Central Oklahoma were screened for participation in the study using the Visual Aural Digit Span (VADS) and Raven's Coloured Progressive Matrices (Raven's). The VADS was administered to each student by an examiner trained in the use of the measure who was completing certification work as a school psychometrist. The Raven's was administered by the same examiner to small groups of seven students or less. Eighty-seven students were screened with the VADS and Raven's.

The VADS and Raven's of each student was scored using age norms provided by the publishers of the tests. Students scoring at or below the twenty-fifth percentile rank on the VADS while scoring at or above the fiftieth percentile rank on the Raven's matrices were termed as having deficient successive processing skills with adequate simultaneous processing skills. Students scoring at or below the twenty-fifth percentile rank on the Raven's matrices while scoring at or above the fiftieth percentile rank on the VADS for their age were termed as having deficient simultaneous processing skills with adequate successive processing skills. From the eighty-seven students screened for inclusion in the study, seventeen were found to be deficient in successive processing and eighteen were found to be deficient in simultaneous processing as defined by their relative performance on the VADS and Raven's Coloured Progressive Matrices.

From this pool of subjects, participants were randomly assigned to one or the other of two teaching strategy treatment conditions or to a control group based on their processing deficiency. Thereby, subjects having deficiencies in successive processing or simultaneous processing could receive either a successive or simultaneous word processing training or to a control condition. This created five groups with seven subjects within each group. The control group had a mixture of children with successive or simultaneous processing deficits for use in evaluating the general impact of the training. The remaining four groups were treatment groups in a two X two factorial design. The first factor was the independent organismic variable of information processing which had two levels--simultaneous or successive cognitive processing deficiency. The other two levels in the factorial design represented the factor of teaching strategies which could be received constituting an independent stimulus variable as the other dimension of this factorial design. Thereby, subject representation and treatment representation problems found in other studies (Gunnison & Kaufman, 1982; Hobby, 1981; Kaufman, 1978; Krywaniuk, 1974; and Leasak, Hunt, and Randhawa, 1982) could be overcome and tested within one experimental design.

Teacher Training

Each regular classroom teacher serving as a teacher-trainer was familiarized with the treatments the week before treatments were to begin. Each teacher was provided with two three-ring binder notebooks.

Each notebook was clearly marked as being the "Pattern" (simultaneous teaching strategy) or "Series" (successive teaching strategy) materials. In addition, each teacher-trainer was given small four by eleven inch cardboard sheets which were to be used to cover significant portions of words taught in the word processing training based on which training was offered. Teacher-trainers were given a minimum of twenty minutes training in which the exact training procedures were explained. Teachers were then asked to give the training to this author to insure they knew how to properly handle all materials and so they could become familiar with the materials. Teachers were given rosters listing children to receive the "Patterns" or "Series" treatment. It was clearly explained that students must receive the proper training prescribed for them and that the training should be given as near the same time of day as possible, each day, for two weeks. Further, it was explained that students listed as "control" were not to receive instruction but should be allowed to color, read, or engage in seat activity not associated with normal classroom activity while either a "Pattern" or "Series" treatment was being given but not both. Printed instructions for the presentation of the words during the process training were fixed to the loose leaf notebooks for easy reference and each teacher was asked to read these instructions to make certain they were understood.

Many precautions were employed to reduce threats to internal and external validity. First, teachers were not aware of the hypotheses prior to the completion of the study. Second, the ways in which the words were presented in the two word processing strategies and the ways in which knowledge of the words was tested remained consistent between groups. Third, the presentation of the words was given in very small groups with the teacher sitting with the children as in a reading group thereby gaining and maintaining their attention. Fourth, children in the control group were allowed time to color or work on classroom projects during the time students involved with training were instructed in the processing of words.

Training Strategies

Following Hobby's (1981) work, children were taught to process and remember words in either a successive or simultaneous manner. Both word processing teaching strategies made use of loose leaf notebooks with words to be taught on individual pages and small cardboard cards were used with the notebooks to focus the visual presentation of words for the subjects during training. The teachers using the notebooks read specific instructions to subjects prior to each training session.

The word presentation methods were very similar to the method used by Hobby (1981) save for the type of media used. The present author opted for materials which would be more easily handled by the teachers, less foreign for the students, and be more conducive to insuring student interest, attention and participation. Hobby (1981) made use of video-taped presentations.

The successive word processing strategy taught the simulated words from Appendix A in a particular fashion. The training in successive processing of words was called the "Series" training for the benefit of the teacher-trainers. The teacher-trainers were given notebooks containing the words on which the training was based as well as full instructions. The instructions were reminders for the teacher-trainers as they had been given a full rehearsal of how to conduct training, pronounce words, and organize their materials. The notebooks were arranged so that the stimulus words to be viewed by students were written in large letters (a minimum of two inches in height mimicing the font used in their second grade readers) and were properly oriented for view. Written upside down on the corner of each page were the words the teacher-trainer was presenting. The words were written upside down from the direction words were presented to the students so that the teachers would not have to rotate the materials to see what words they were presenting and so they could present the words with little hesitation or uncertainty.

Successive Word Processing Strategy. Instructions for training given to the teachers and printed in the notebook for the "Series" (successive processing) training were as follows:

> Words you will be saying to the students are written in the lower right hand corner of the page as the page faces the students. Read each carefully to make sure these nonsense words are pronounced correctly. Cover the page with the enclosed shields. Say to students "We are going to read words that are not real words. They will help us read real words." Begin with the first page and remind the students to "Look at each word carefully.". Cover the top word whose letters are distributed along the length of the page and the word at the bottom of the page. Say the word then expose the letters one at a time as you say the letters. Point to this word with one hand as the shield is being moved with the other. Then say the word again while exposing the word at the bottom portion of the page. Wait three seconds and continue with the next word. If the students spontaneously say the words, allow them to do so unless it interferes with other youth in the group.

Each word from the list of words was first pronounced. Each letter of the word would then be pronounced as the word was exposed one letter at a time using a small card until the complete word was presented to the students (e.g., for the simulated word "fak": the page showing the word printed in large block letters was set on a table facing the students and the teacher said the word "fak". The "f" was then exposed as the letter is named, then "a" is added to show "fa" and "a" is named, then "k" is added to show "fak" and the letter "k" is spoken.). The letters of the words were pronounced as letter names. After the word is pronounced, the word is given a three-second exposure and then the next word is presented. All of the words from the list were introduced during each training session. The training was administered daily for two weeks. The training lasted roughly ten minutes per session. As Hobby (1981) has indicated, since the presentation facilitates processing the words temporally and successively, this approach would approximate a successive information processing strategy.

Simultaneous Word Processing Strategy. The simultaneous processing strategy deviated from that used in the Hobby (1981) study for important reasons. Hobby (1981) used the aural and visual presentation of the word (identical to those used in the successive teaching strategy) for the same number of seconds of exposure as for the successive processing teaching mode. The word was pronounced again. It is seen here that the integrity of Hobby's simultaneous processing teaching strategy should be questioned. While the reading of a whole word automatically would constitute a simultaneous approach to reading, no process has been taught or suggested. Also, much less was happening on the viewing screen during this training as compared to the successive processing training. In a society as ours where children watch a great deal of television as entertainment, more "activity" on the viewing screen would be necessary in order to hold their interest. To solve both problems, two simulated words were presented in the simultaneous word processing teaching strategy. This training was given the name "Patterns" for the benefit of the teacher-trainers. The first word presented was identical to those used in the successive processing training as adopted from Hobby (1981). The second word was a word that retained the same basic pattern (See Appendix B) with one or two letters changed while still being a simulated word.

The reason for deviating from Hobby's approach is because Das, Kirby, and Jarman (1979) view this sort of integration (simultaneous processing) as the forming of systems of relationships. When systems of relationships are to be grasped, the components of those systems must be represented simultaneously. For the present study, the system is to retain knowledge of a word processing system which will generalize to the reading and spelling of words to be encountered later. Given that the ability to read a group of letters can be transferred to reading those letters in another word, and assuming that knowledge of those letters help in the process of reading or spelling a word, teaching such a system by simultaneously presenting words in a fashion which reinforces words as a class (from which children can generate and read other words) would better constitute a simultaneous word processing strategy.

To operationalize this notion, two words were pronounced by the teacher as the sheet of paper in the loose leaf notebook was prepared for viewing by the students. The words on the top of each page were identical to those used in the successive processing training. The second word on the page was another simulated word created through the substitution of one or two letters. The first word was shown and pronounced. Then the second word was shown and pronounced. The letter or letters to be substituted in the second word were underlined. The two words were then pronounced one after the other with both words simultaneously in view of the students. For example, "frek" and "frep" were pronounced. "Frek" was exposed from beneath a cardboard cover and pronounced. Then the word "frep" was shown below "frek" as it was pronounced. Both words would then be pronounced while shown together. The portion of the word changed is underlined to demonstrate that the change does not affect the rest of the word and the way that portion of the word sounds from word to word. The students were allowed to view the words for three seconds and the next pair of words were presented in a like fashion. The word forms are listed in Appendix B. The time donated to the strategy training for this treatment was the same per word (word form) as in the successive training so that time of exposure to the words would not be a factor in and of itself. As in the successive processing training, the training was administered daily for two weeks. The training lasted roughly ten minutes per session.

The directions given the teacher-trainers for the "Patterns" (simultaneous processing) teaching strategy were as follows:

> Words you will be saying to the students are written in the lower right hand corner of the page as the page faces the students. Read each carefully to make sure these nonsense words are pronounced correctly. Cover the page with the enclosed shield. Say to students "We are going to read some words that are not real words". "They will help us read real words." Begin with the first page and remind the students to "Look at each word carefully.". Expose the top

> word to the students as you say the word keeping the bottom word covered. Move the shield to cover the top word while exposing and pronouncing the bottom word. Remove the shield to expose both words for three seconds then move on to the next page. If students spontaneously say the words, allow them to do so unless it interferes with other youth in the group.

As related previously, each group of students selected for the simultaneous or successive processing training viewed the appropriate materials under the instruction of their regular classroom teacher ten minutes per day for two weeks. Each presentation session exposed subjects to all simulated words from Appendix A or Appendix B. The time of day the presentations were viewed by the subjects were kept as similar as possible for both groups to diminish the effects that the time of day would have on the subjects' motivation and attention. Seating was arranged so all subjects could clearly see the materials depicting the words on which the processing training was based. No teacher-trainer had more than five subjects in any one "Series" or "Patterns" group. The control group was asked to engage in seat work for a similar amount of time that it took to complete the processing training in that they were to take a break from normal classroom activities while a treatment was taking place and draw, color, or engage in independent reading activity.

Pre- and Posttesting Procedures

All subjects had been pretested with the VADS test and the Raven's matrices as previously mentioned for subject selection. Posttesting on the measures of reading and spelling of simulated and English words took place the beginning of the week following the two week training period. In addition to dependent measures of interest, "Reading" and

"Spelling" sections of the Wide Range Achievement Test (WRAT) (Jastak and Jastak, 1978) were administered as a posttest to assess equivalence of the groups.

Spelling posttesting was effected by four examiners testing the children in groups of seven to ten with children first spelling fifty simulated words then fifty English words (See Appendix A.). The words were pronounced twice for the students in the case of spelling simulated words. The words were pronounced, spoken in a sentence (Appendix C), then pronounced again in the case of spelling English words. The examiners closely monitored the progress of students so that no one would be left behind or so that no blanks were left on their paper. Reading posttesting for English and simulated words was effected with each child individually by one of the four examiners who were either certified as psychometrists or school psychologists or where in training for certification. Words that were mispronounced were marked with notations typically used in analyzing word attack on reading diagnostic tests. Behavioral information was noted as subvocalization on the part of subjects or other behaviors of interest. The test of reading simulated words preceded the test of the reading of English words. Reading posttesting followed spelling posttesting in all cases and English word posttesting always followed simulated word posttesting. The WRAT was the last measure administered. Posttesting of all subjects in the study on the reading and spelling of simulated and English words took place on the same day. In this way, the time between training and posttesting remained essentially the same for all tasks. Reading posttesting was conducted after spelling posttesting so the subjects would not have a chance to see the words used in training right before spelling them and, hence, confounding the results. All of the reading and spelling tasks using the English and simulated words were created by placing the words in a random order from that in which the words were taught. The subject selection, training, and posttesting all took place during the late Spring of 1983.

Analysis of Data

The first comparison of data regarded differences between the group with a deficiency in successive processing ability and the group with a deficiency in simultaneous processing ability regarding the effectiveness of the successive or simultaneous word processing training session on the reading and spelling of words from the posttest. This was performed by subjecting data to 2 X 2 between subjects ANOVAs. The second type of comparison regarded the differences between treatment groups and the placebo group in the number of words which could be spelled and read after training. This was effected through the use of one-way between subjects ANOVAs.

CHAPTER IV

RESULTS

Introduction

The purpose of this chapter is to present the results of the statistical analysis of data secured in the study. The problem regarded whether or not there would be differential effects in teaching simultaneous or successive word processing strategies to children deficient in successive or simultaneous cognitive processing skills. Such would be predicted by the available literature but has not been fully substantiated. The target task in this study is the reading of simulated words on which teaching strategies were based. Other dependent measures of interest were the reading of English words which were similar to the simulated words and the spelling of English and simulated words. Other data collected were standard scores from the "Spelling" and "Reading" subtests of the Wide Range Achievement Test (Jastak & Jastak, 1978) to test the equivalence of the groups selected for experimental and control conditions.

The first general analysis of data examined the equivalence of treatment groups reflected in WRAT standard scores. This analysis was performed using a 2 X 2 between group ANOVA. The second general analysis of data regarded testing the differential effects of teaching simultaneous or successive word processing strategies to children deficient in simultaneous or successive information processing. This

TABLE I

KEY TO LETTER INDICATORS FOR
FACTORS USED IN TABLES

A = Assessed Processing Deficiency of Subjects	
	a1 = Deficiency in Successive Processing of Information
	a2 = Deficiency in Simultaneous Processing of Information
B = Teaching Strategy Experienced by Subjects	
	b1 = Successive ("Series") Teaching Strategy
	b2 = Simultaneous ("Patterns") Teaching Strategy
C = No Treatment Employed for Subjects	

was performed using a series of 2 X 2 ANOVAs across treatment conditions and subject groups using the number of English and simulated words correctly read and the number of English and simulated words correctly spelled as dependent measures. The third analysis of data regarded whether or not there were differences between the control and treatment groups on the same dependent measures. This analysis was performed using a series of one-way ANOVAs. Finally, the results were analyzed in light of stated research hypotheses.

Tests of Group Differences

Table II reveals means and standard deviations for all data collected in posttesting after the experimental treatment period. Data for the reading and spelling of English and simulated words reflect the

TABLE II

MEANS AND STANDARD DEVIATIONS FOR
TREATMENT AND CONTROL GROUPS
FOR DEPENDENT MEASURES

	GROUPS*									
	a1b1		a1b2		a2b1		a2b2		C	
	M	SD	M	SD	M	SD	M	SD	M	SD
(1)	45.4	3.5	39.9	12.0	42.1	4.1	35.4	11.9	31.6	12.9
(2)	43.4	5.9	42.1	8.5	45.7	4.2	40.3	7.8	38.6	9.8
(3)	27.9	9.5	24.9	4.7	28.9	6.8	20.4	2.2	13.7	4.6
(4)	34.7	9.4	37.6	3.1	36.0	6.6	29.7	10.6	34.1	7.6
(5)	109.7	12.4	103.9	12.8	102.4	15.0	104.0	9.9	103.6	15.9
(6)	103.3	12.4	103.1	12.6	104.4	16.3	102.3	11.4	98.8	11.3

* *n* = 7 per group
Dependent Measures: (1) = Reading Simulated Words; (2) = Reading English Words; (3) = Spelling Simulated Words; (4) = Spelling English Words; (5) = WRAT Reading; (6) = WRAT Spelling.
See TABLE I for Key to Group Identification.

number of words correctly read and spelled by subjects with a maximum of fifty possible. Table I outlines letter indicators used in this and subsequent tables to aid in identifying group membership.

As can be seen in Table II, the means for the control and treatment groups are very similar for *WRAT* "Reading" and "Spelling" standard scores and, as reflected in Table III and Table IV, there were no significant main effects for processing deficiencies ($F = .645$; $p >$

TABLE III

ANALYSIS OF VARIANCE SUMMARY TABLE
FOR WRAT READING

Source	SS	df	MS	F
Processing (A)	89.286	1	89.286	.645*
Strategies (B)	32.143	1	32.143	.232*
A X B	96.571	1	96.571	.697*
Error	3324.000	24	138.500	
Total	3542.000	27		

*$p > .05$

.05) or teaching strategies ($F = .232$; $p > .05$) nor was there any interaction ($F = .697$ & .039; $p > .05$). This suggested that the effects of having five different teachers as experimenters (each teacher acted as an experimenter for children in each treatment group), and any effects of the children being from two school districts (again represented in each group) were minimal or nonexistent. Table II further shows that fifteen of the sixteen treatment groups had higher average scores on the dependent measures of interest as compared to their control counterparts who received no treatment.

The next consideration regarded whether or not there were any significant differences among the treatment groups in the number of words correctly spelled and read as a result of the experimental treatments and the effects of the treatment on children with differential abilities in simultaneous or successive cognitive processing of information. It was anticipated that there would be differential effects of teaching particular word processing strategies

TABLE IV

ANALYSIS OF VARIANCE SUMMARY TABLE
FOR WRAT SPELLING

Source	SS	df	MS	F
Processing (A)	.143	1	.143	.001*
Strategies (B)	9.143	1	9.143	.051*
A X B	7.000	1	7.000	.039*
Error	4269.429	24	177.893	
Total	4285.714	27		

*$p > .05$

to children with measured strengths and weaknesses in information processing ability as a result of the experimental treatments described in the previous chapter.

Tables V, VI, VII, and VIII provide summaries of four 2 X 2 ANOVAs to investigate this question. The analysis of data showed what the only significant effect in providing a simultaneous or successive word processing strategy to children deficient in the simultaneous or successive processing of information was shown in the spelling of simulated words. Table VII reflects that there was a significant teaching strategy main effect for the spelling of simulated words (F = 5.562; $p < .05$). An inspection of the means from Table II showed that children better spelled simulated words when taught to read simulated words with a successive word processing rather than with a simultaneous word processing strategy (combined mean of 28.4 versus 22.6 simulated words spelled). A strength of association test in the form of the omega squared (Linton & Gallo, 1975) was calculated which showed the

TABLE V

ANALYSIS OF VARIANCE SUMMARY TABLE
FOR READING SIMULATED WORDS

Source	SS	df	MS	F
Processing (A)	104.143	1	104.143	1.329*
Strategies (B)	264.143	1	264.143	3.370*
A X B	2.286	1	2.286	.029*
Error	1881.143	24	78.381	
Total	2251.714	27		

*$p > .05$

experimental effect to be rather weak ($\omega^2 = .14$). The omega squared statistic used to determine the strength of association aids in accounting for the variance associated with the treatments which are being applied in the study. Omega squared provides an estimate of the strength of association in the population (Linton & Gallo, 1975). No other processing deficiency main effects, teaching strategy main effects, or interactions were found to be statistically significant as shown in Tables V, VI, and VIII.

Tables IX, X, XI, and XII summarize the results of a series of one-way ANOVAs calculated to see if there were any differences between the control and treatment groups on the number of simulated and English words correctly read and the number of simulated and English words correctly spelled after the experimental treatments for the children deficient in simultaneous or successive cognitive processing of information. As can be seen in Table XII, the only significant main effect, once again, related to the spelling of simulated words ($F = 7.276$; p <

TABLE VI

ANALYSIS OF VARIANCE SUMMARY TABLE
FOR READING ENGLISH WORDS

Source	SS	df	MS	F
Processing (A)	.321	1	.321	.006*
Strategies (B)	78.893	1	78.893	1.710*
A X B	30.036	1	30.036	.651*
Error	1107.429	24	46.143	
Total	1216.679	27		

*$p > .05$

.01). This means that there was at least one significant difference among the treatment and the control groups. A stronger strength of association statistic was obtained for this main effect ($\omega^2 = .417$) which suggested that training did have an impact on the treatment groups which was more evident when their achievements were considered alongside those who received no training. The Newman-Keuls test (Kirk, 1968) was used to discover where the significant differences could be found among the groups.

The Newman-Keuls test was used because it is rather nonconservative yet is relatively powerful for techniques used to make pairwise comparisons of means in ANOVA. As the comparison of the control and treatment groups is only a secondary consideration, the nonconservative nature of the test or increased possibility of erroneously rejecting a null hypothesis was not of tremendous concern. This information is summarized in Table XIII. As can be seen, there was a significant difference between the means of the treatment groups and the control

TABLE VII

ANALYSIS OF VARIANCE SUMMARY TABLE
FOR SPELLING SIMULATED WORDS

Source	SS	df	MS	F
Processing (A)	20.571	1	20.571	.501
Strategies (B)	228.571	1	228.571	5.562*
A X B	51.571	1	51.571	1.255
Error	986.286	24	41.095	
Total	1287.000	27		

*$p < .05, 1, 24$

group used in this study in the spelling of simulated words. No significant main effects were obtained for the reading of simulated words (Table IX), the reading of English words (Table X) or the spelling of English words (Table XI).

Unplanned Comparisons

It is quite evident in inspecting the descriptive statistics from the target task in Table II, the reading of simulated words, that there were large differences among the group standard deviations in that some were almost four times greater than others. This concerned the present author in that there might be significant differences among variances which could influence whether or not significant differences which might exist could be found. An overall one-way ANOVA failed to yield a significant F (F = 2.183; p > .05; Table IX) for this dependent measure. The error term in this comparison is by far the largest among the series reflecting the performance of the treatment groups and the

TABLE VIII

ANALYSIS OF VARIANCE SUMMARY TABLE
FOR SPELLING ENGLISH WORDS

Source	SS	df	MS	F
Processing (A)	75.571	1	75.571	1.200*
Strategies (B)	20.571	1	20.571	.326*
A X B	146.286	1	146.286	2.315*
Error	1516.571	24	63.190	
Total	1758.999	27		

*$p > .05$

control group (Tables IX to XII). Consequently, F-Ratios were generated among all of the groups tested on the reading of simulated words to test for homogeneity of variances. As Runyon and Haber (1976) explain, significant differences in variances, if anything, would tend to lower the likelihood of rejecting a null hypothesis. These F-Ratios are seen in Table XIV.

As is evident in Table XIV, six of the ten possible pairwise comparisons of variances among the five groups yielded significant F-Ratios. As a consequence, it was thought that there was an increased likelihood of making a type II error; i.e., accepting a false null hypothesis. Therefore, four one-way ANOVAs were calculated which compared treatment group scores with the control group scores. Though such a technique does not use an experiment-wise error rate, any problems in making numerous pairwise comparisons (as increasing the likelihood of a type I error) are most likely offset by the lack of homogeneity of variance and lessened likelihood of finding differences

TABLE IX

ANALYSIS OF VARIANCE SUMMARY TABLE FOR READING SIMULATED WORDS ACROSS CONTROL AND TREATMENT GROUPS

Source	SS	df	MS	F
Between Groups	838.686	4	209.671	2.183*
Error	2880.875	30	96.029	
Total	3719.543	34		

*$p > .05$

which might in fact exist.

The results of these pairwise comparisons are shown in Table XV. As can be seen, there was one significant main effect in that children with successive processing deficits receiving successive word processing training did significantly better on the task than did controls ($F = 7.713$; $p < .01$). No other comparisons were significant.

Tests of Research Hypotheses

Research Hypothesis No. 1:

Children low in successive information processing ability with adequate simultaneous information processing ability will read simulated words best when they are taught to read a set of simulated words with a simultaneous word processing teaching strategy rather than with a successive word processing strategy. This hypothesis was rejected in favor of the null hypothesis. There was no word processing treatment main effect, subject type main effect, or interaction associated with

TABLE X

ANALYSIS OF VARIANCE SUMMARY TABLE FOR READING
ENGLISH WORDS ACROSS CONTROL
AND TREATMENT GROUPS

Source	SS	df	MS	F
Between Groups	213.829	4	54.457	.952*
Error	1683.143	30	56.105	
Total	1896.971	34		

*$p > .05$

the reading of simulated word forms as evidenced in the ANOVA found in Table V.

Research Hypothesis No. 2:

Children low in simultaneous information processing ability with adequate successive information processing ability will read simulated words best when taught to read a set of simulated words with a successive word processing strategy than with a simultaneous word processing strategy. This hypothesis was rejected in favor of the null hypothesis as well. As mentioned regarding Research Hypothesis No. 1, there was no word processing treatment main effect, subject type main effect, or interaction associated with the reading of simulated word forms as evidenced in the ANOVA found in Table V.

Research Hypothesis No. 3:

Children low in successive information processing ability with

TABLE XI

ANALYSIS OF VARIANCE SUMMARY TABLE FOR SPELLING ENGLISH WORDS ACROSS CONTROL AND TREATMENT GROUPS

Source	SS	df	MS	F
Between Groups	243.143	4	60.786	.979*
Error	1861.429	30	62.048	
Total	2104.571	34		

*$p > .05$

adequate simultaneous information processing ability will read English words best when they are taught to read a set of simulated words with a simultaneous word processing teaching strategy rather than with a successive word processing strategy. This hypothesis was rejected in favor of the null hypothesis. As shown in the ANOVA presented in Table VI, there was no significant treatment main effect, subject main effect, or interaction associated with the reading of English words.

Research Hypothesis No. 4:

Children low in simultaneous information processing ability with adequate successive information processing ability will read English words best when taught to read a set of simulated words with a successive word processing strategy than with a simultaneous word processing strategy. This hypothesis was rejected in favor of the null hypothesis as well. As shown in the ANOVA presented in table VI, no significant treatment main effect, subject main effect, or interaction was shown in association with the reading of English words.

TABLE XII

ANALYSIS OF VARIANCE SUMMARY TABLE FOR SPELLING SIMULATED WORDS ACROSS CONTROL AND TREATMENT GROUPS

Source	SS	df	MS	F
Between Groups	1078.571	4	269.643	7.276*
Error	1111.714	30	37.057	
Total	2190.286	34		

*$p < .01; 4, 30$

Research Hypothesis No. 5:

Children low in successive information processing ability with adequate simultaneous information processing ability will spell simulated words best when they are taught to read a set of simulated words with a simultaneous word processing teaching strategy rather than with a successive word processing strategy. The ANOVA seen in Table VII shows there to be a significant word processing strategy main effect associated with the spelling of simulated words. However, there was no processing deficiency main effect or interaction leading to the rejecting of this hypothesis in favor of the null hypothesis.

Research Hypothesis No. 6:

Children low in simultaneous information processing ability with adequate successive information processing ability will spell simulated words best when taught to read a set of simulated words with a

TABLE XIII

PAIRWISE COMPARISON OF MEANS BETWEEN CONTROL AND TREATMENT GROUPS FOR THE SPELLING OF SIMULATED WORDS

	C	a2b2	a1b2	a1b1	a2b1
	M = 13.7	20.4	24.9	27.9	28.9
C = 13.7	----	6.7*	11.2**	14.2**	15.2**
a2b2 = 20.4		----	4.5	7.5	8.5
a1b2 = 24.9			----	3.0	4.0
a1b1 = 27.9				----	1.0
a2b1 = 28.9					----

*$p < .05$; CV(2)= 6.65; CV(3)= 8.03; CV(4)= 8.86; CV(5)= 9.43
**$p < .01$; CV(2)= 8.95; CV(3)=10.24; CV(4)=11.04; CV(5)=11.62

See Table I for Key to Group Identification.

successive word processing strategy rather than with a simultaneous word processing strategy. The ANOVA seen in Table VII shows there to be a significant treatment main effect associated with the spelling of simulated words. However, there was no subject main effect or interaction leading to the rejecting of this hypothesis in favor of the null hypothesis.

Research Hypothesis No. 7:

Children low in successive information processing ability with adequate simultaneous information processing ability will spell English

TABLE XIV

F-RATIOS ACROSS TREATMENT AND CONTROL GROUPS FOR THE READING OF SIMULATED WORDS

	GROUPS				
	C	a1b2	a2b2	a2b1	a1b1
	SD = 12.908	11.950	11.914	4.059	3.505
	SD^2=166.619	142.809	141.952	16.476	12.286
C	----	1.167	1.174	10.113*	13.562*
a1b2		----	1.006	8.668*	11.624*
a2b2			----	8.616*	11.554*
a2b1				----	1.3410
a1b1					----

*$p < .05$; CV = 5.82. See Table I for Key to Group Identification.

words best when they are taught to read a set of simulated words with a simultaneous word processing teaching strategy rather than with a successive word processing strategy. The ANOVA summarized in table VIII shows no significant subject main effect, treatment main effect, or interaction associated with the spelling of English words. Therefore, this hypothesis is rejected in favor of the null hypothesis.

TABLE XV

SUMMARY ANOVAS FOR PAIRWISE COMPARISONS BETWEEN TREATMENT AND CONTROL GROUPS ON THE READING OF SIMULATED WORDS

Source	SS	df	MS	F
a1b1 v C	672.071	1	672.071	7.713*
Error	1073.428	12	89.452	
Total	1745.5	13		
a1b2 v C	240.286	1	240.286	1.553
Error	1856.571	12	154.714	
Total	2096.857	13		
a2b1 v C	391.143	1	391.143	4.272
Error	1098.571	12	91.548	
Total	1489.714	13		
a2b2 v C	52.071	1	52.071	.337
Error	1851.429	12	154.286	
Total	1903.50	13		

*$p < .01;1,12$

Research Hypothesis No. 8:

Children low in simultaneous information processing ability with adequate successive information processing ability will spell English words best when taught to read a set a simulated words with a successive word processing strategy rather than with a simultaneous word processing strategy. The ANOVA summarized in table VIII shows no significant subject main effect, treatment main effect, or interaction associated with the spelling of English words. Therefore, this hypothesis is rejected in favor of the null hypothesis.

CHAPTER V

CONCLUSIONS AND DISCUSSION

Introduction

The purpose of this study was to determine if there were differential effects in teaching a simultaneous or successive word processing strategy to children with simultaneous or successive information processing deficits. This study was operationalized by teaching word processing strategies based on simulated words to four treatment groups with seven students in each group. Subjects were selected who had simultaneous or successive information processing deficits as defined by the VADS (Koppitz, 1977) and Raven's Coloured Progressive Matrices (Raven, 1956). The subjects were randomly assigned to receive either a simultaneous word processing teaching strategy or a successive word processing teaching strategy or be in a control condition.

Dependent measures were the number of simulated and real English words that could be correctly spelled and the number of simulated and real English words that could be correctly read. The words were adopted from Hobby (1981) and taken from the Starlin and Starlin (1972) curriculum ladder. The treatments were administered over a two week period with posttesting on dependent measures taken the following week.

Summary of Results

Subject to the scope and limitations of this study, it was found that it made very little difference whether or not children deficient in simultaneous or successive information processing skills received a simultaneous or successive word processing strategy. Though all but one group benefited from the treatments by raw mean scores in comparison to the control group which received no word processing treatment, little if any evidence was obtained which suggested that it was really of benefit to match a given word processing strategy with a given information processing deficit.

The only main effect realized was a teaching strategy difference related to the spelling of simulated words. Children who received the successive word processing strategy for two weeks were able to spell simulated word forms significantly better than those who had received the simultaneous word processing strategy. Those children subjected to the simultaneous word processing strategy may have been more inclined to see more alternatives to spelling the simulated words than those who received the successive processing training.

Still, all that can be said is that the treatment groups did better than the control groups on the dependent measures, though not significantly so in all cases. There were no differential effects based on the organismic variable of information processing strengths and weaknesses and the stimulus variable of training.

Implications

This study did not help a great deal in determining the validity of translating the theory of simultaneous or successive cognitive processing of information to educational practice. Many problems were evident in studies which had been conducted addressing this area which still remain. What the study does show is that the simple matching of strategies with information processing skills does not make for readily identifiable differences in the performance of learners. The work of Hobby (1981), Gunnison and Kaufman (1982), Kaufman (1978), and Krywaniuk (1974) to show that information based processing training can make a difference is still suspect because of the basic flaws in the research designs. Factorial designs are the simplest designs which should be required in this type of research with at least one factor being differential information processing abilities. The above mentioned research relied too heavily on one information processing trait or one type of information processing training. Further, nontreatment ANOVA designs as found in Kirby and Das (1977) are really inappropriate for research in this area. While studies may show that information processing based training may be feasible, these studies do not show an aptitude by treatment interaction that points to specific remediation techniques being needed for children having one type of information processing problem or another. Much work still needs to be done to determine the role of simultaneous and successive information processing in new learning. Remediation suggestions provided by Gunnison, Kaufman, and Kaufman (1982) and Kaufman and Kaufman (1983a) are still experimental and should be viewed as suspect as previous ability training programs found faulty as the work in neurological organization (e.g., Ayers, 1972), perceptual training (e.g., Frostig, 1967), and perceptual-motor training (e.g., Kephart, 1971).

As a post hoc analysis to satisfy some curiosity, Pearson Product Moment Correlation Coefficients were calculated between all raw scores for selection measures used (VADS and Raven's Matrices) and raw scores from dependent measures of interest for those subjects in treatment conditions. These statistics can be seen in Table XVI. Many of the results were anticipated. For example, there was a significant correlation between reading simulated words and reading English words ($r = .584$, $p < .01$; df = 26) and between the spelling of simulated words and the spelling of English words ($r = .407$, $p < .05$; df = 26). The reading of simulated words and the spelling of English words was also significantly related ($r = .571$, $p < .01$; df = 26). This may speak to how word attack skills will foster the accurate reading of words. The VADS and Raven's were negatively correlated (-.35) most likely due to the subject selection methods employed (See Chapter III). What was somewhat surprising is that Raven's Matrices showed almost no relationship to any of the dependent measures (.156 being the highest) and the only moderate correlation for the VADS was its negative relationship with the spelling of simulated words (-.32). Is it possible that strengths in successive processing interfere with the spelling of simulated words as used in this study? This seems unlikely as the teaching strategy effect shown in Table VII indicated that successive word processing training best facilitated the spelling of simulated words. The Raven's Coloured Progressive Matrices and the VADS explained very little of the variance in performance on the reading and spelling exercises employed in this study and the VADS yielded one very confusing relationship with the spelling of simulated words.

The reason this information is worthy of note is this: though simultaneous and successive information processing skills have been shown to differentiate between below-average and average readers and

TABLE XVI

INTERCORRELATIONS AMONG INDEPENDENT AND DEPENDENT MEASURES

	X1	X2	X3	X4	X5	X6
X1	----	-.350	.035	.156	.076	.116
X2		----	-.320	-.170	.025	.143
X3			----	.407*	.269	.322
X4				----	.571**	.251
X5					----	.584**
X6						----

*p < .05
**p < .01
Where X1 = Raven's Matrices; X2 = VADS; X3 = Spelling Simulated Words; X4 = Spelling English Words; X5 = Reading Simulated Words; X6 = Reading English Words

average readers and above-average readers (Leong, 1980) and to have explanatory power in describing learning handicaps (e. g., Cummins & Das, 1980), the processes may be independent enough in normal children that the effect of training to an assumed deficit or strength may not yield neat and clean effects as would be anticipated from an aptitude by treatment interaction. It is curious that for both Hobby's study (1981) and the present study, the successive strategy was the best method for showing treatment effects even with a vastly improved simultaneous word processing teaching strategy being used in the present study. The concept that these information processing dimensions are equally balanced in importance to academic outcomes may be faulty. While these information processes may not be hierarchical as Jensen's (1970) Level I and Level II abilities, one or the other of simultaneous and successive (sequential) synthesis may be irrelevant to some academic attainments.

Limitations

The notion of assessing information processing skills is no doubt appealing on at least two levels. For the first, an attempt is made to somehow bring assessment to a level of essential information processing conducted by the learner not complicated to the greatest extent possible by such things as formal education. For the second, if the mechanisms of information processing can be identified somehow, affecting those mechanisms in a positive way may help a broad class of important mental and academic behaviors. As stated in the introductory chapter, there is an attempt to teach processes in the hope that a learning or adjustment problem will be remediated.

The present research did little but show that it really made no difference what type of processing strategy was afforded this group of children in light of a processing deficiency. The differences shown by Hobby (1981) for children with successive processing deficits who received successive word processing training were not realized here even when processing training was for an identical period of time. Differences because of training was shown as it was in Gunnison and Kaufman (1982) but not for children with one particular information processing strength or deficit.

Some possible difficulties with the present research that limit its usefulness are explained in what follows. This study had a small subject pool mainly due to the standards used for subject selection. Such a small number of subjects affects the power of statistical techniques to detect any differences between groups. The small sample size was due more from research constraints than as a choice of this author. Also, the study only dealt with words which can be labelled as representing domains of word categories based on their structure. Thereby, any results only point to differences in simple word recognition and spelling rather than other elements needed for the reading act as lexical access or the combination of thought to foster comprehension. Further, the study in no way supports or refutes the existence of simultaneous or successive (sequential) cognitive processing of information as a viable model to explain human abilities. The theory itself was not tested with the results of this study.

At most, the present study tested the translation of theory to educational practice with sight word reading strategies. This author would require, though, that more significant differences be demonstrated showing a greater impact of the training in contrast to experimental controls before statements be made as to the validity of translating this neuropsychological theory into educational practice.

Another limitation of this study has to do with significant differences being shown between controls and experimental subjects in the reading and spelling of simulated words yet there being no significant differences between controls and experimental subjects in the reading and spelling of English words. Reading and spelling for second graders is a highly controlled activity with a great deal of strategy training taking place in the classroom. The strategy training used in the classroom no doubt comes from the reading and spelling materials available to the teacher in conjunction with any philosophies adopted by or placed on the teacher for how reading and spelling should be taught. In other words, these second graders had been through strategy training directed towards the second grade level reading and spelling of English words for about 160 days prior to this study starting. The students in this study were, for the most part, academically average. Being as such, they no doubt had adopted certain knowledges and mediated learning experiences (see Feuerstin, et al., 1979, 1980) which they could use pretty effectively to read and spell words. Most likely, when asked to read and spell English words as participants in this study, the children most likely reverted to existing strategies they learned in the classroom. When asked to read and spell simulated words they probably had to rely on or make us of the new strategies used with them in the form of word processing teaching strategies. The reason Hobby (1981) found differences in gain scores for most all of his dependent measures is most probably because he was working with "strategy deficient" children is the form of learning disabled students. Hobby (1981) may have taught his group a strategy they could really use. In the case of this research, children asked to read and spell English words did not necessarily have strategy deficiencies even though they may have had information processing deficiencies. When the subjects' abilities to read and spell the English words were tested, this author may have been assessing how well the subjects, control or treatment, were using classroom based strategies rather than experiment based strategies. In other words, subjects of this study may have only applied word processing strategies of this study to less familiar tasks as the spelling and reading of simulated words. The possibility of this phenomena should be kept in mind when designing future research projects addressing information processing training.

Suggestions for Future Research

There are probably at least three reasons why so few causation and control studies linking simultaneous and successive (sequential) processing theory to educational practice can be found in the literature. The first is that it is so difficult to find an adequate subject pool using subject selection criteria as used in this study. Second, there may be few studies having any significant results to report. Third, there may be little interest in testing the educational relevance of simultaneous and successive information processing. Many practitioners and researchers may figure that if the K-ABC (Kaufman and Kaufman, 1983b) and the model of simultaneous and successive information processing (Das, Kirby, & Jarman, 1975, 1979) is based on theory, then practices based on the theory are proper even if only in concept. Much work in this area still needs to be done. However, much of the work will most likely suffer from some of the same limitations as this research. Consequently, the following suggestion if made for future research.

Future research should combine a curriculum and experimental approach to research how simultaneous and successive information processing may translate to educational practice both for normal students and for educationally handicapped students. Numerous curriculum programs in reading, spelling, and mathematics have been published over the years and many have quite different approaches to how these subject areas should be taught. The various curriculum programs should be carefully inspected as to their thrust and focus and, most importantly, the strategies implicit in the learning which is taking place. The strategies should be conceptually organized or labelled as being sequential, temporal, or analytical in nature (successive processing); global, conceptual, or quantitative in nature (simultaneous processing) or both. A large group of children to be exposed to such curriculum materials should be tested so that a good deal is known of their successive (sequential) and simultaneous processing strengths and weaknesses.

The study should trace the academic performance of children over a good period of time to determine if strengths and weaknesses in the information processing dimensions have any logical relationship to their progress with a given type of curriculum series within a given content area. Further, performance on information processing measures should be monitored closely to determine if the type of strategy training children receive in the schools (in terms of curriculum) affects their abilities in information processing. Such information could prove very useful to determine if the theory of simultaneous and successive information processing does translate nicely to educational practice. Further, approaching the research from a curriculum and experimental framework would overcome limitations placed on the present research. Children are learning strategies every day in school. It is best to determine if their information processing strengths and weaknesses have any relationship with how effective they will be in learning these school based strategies as reflected in how easily they take to curriculum presented and developed in certain ways. Previous research in strategy based training (e.g., Hobby, 1981; Krywaniuk, 1974) has at least shown there to be some feasibility in training in simultaneous and successive cognitive processing of information. A design as suggested here should do a great deal in showing if simultaneous or successive approaches to teaching should be used for children deficient or able in simultaneous or successive cognitive processing of information or if the theory is heuristically important but has no use in practice.

Conclusion

The purpose of this study was to determine if there were differential effects in teaching simultaneous or successive word processing strategies to children deficient in simultaneous or successive cognitive processing of information. It was found that there were no differential effects based on the information processing skills of subjects. The results imply that a great deal of work still must be done to determine if the theory of simultaneous and successive information processing translates to educational practice. Practitioners are reminded that educational strategies based on these information processing variables are still experimental. The present study was limited in that it only dealt with word processing strategies and had a small number of students in each group. Also, researchers must be mindful that children are receiving strategy training of one form or another daily in school and this may affect outcomes of studies as this one. Therefore, future research should combine a curriculum and experimental orientation to determine any link between this theory of information processing and new learning by categorizing curricula based on a successive or simultaneous approach and determining how children respond to such curriculum in relation to their skills in the simultaneous or successive processing of information.

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APPENDIX A

Word Categories with Corresponding Simulated Words and English Words Used in the Experimental Study

	Word Category	Simulated Word	English Word
1.	short a cvc words	lat	hat
2.	short i cvc words	hig	big
3.	short u cvc words	dut	nut
4.	short o cvc words	mot	hot
5.	short e cvc words	ped	red
6.	short vowel "bl-", "cl-", "pl-" words	clon	clog
7.	short vowel "fl-", "gl-", "sl-" words	glap	flap
8.	short vowel "sk-", "sp-", "st-", "sw-" words	skib	skin
9.	short vowel "sc-", "sm-", "sn-", "tw-" words	snad	snag
10.	short vowel "br-", "cr-", "dr-" words	breg	brag
11.	short vowel "fr-", "tr-", words	frek	fret
12.	short vowel "gr-", "pr-", words	prog	prod
13.	short vowel "-nd", "-nt", "-nk" words	fent	sent
14.	short vowel "-st", "-sk", words	jask	bask
15.	short vowel "-lp", "-lf", words	neld	held
16.	short vowel "-ft", "-xt", "-pt" words	jext	next

17.	short vowel "-lt", "-ld", "-mp" words	balt	melt
18.	short vowel "-ck" words	gack	back
19.	short vowel "th(v)" words	thib	this
20.	short vowel "th(uv)" words	lath	bath
21.	short vowel "ch" words	fich	rich
22.	short vowel "-tch" words	datch	match
23.	short vowel "sh" words	shog	shop
24.	short vowel "ng" words	mung	rung
25.	short vowel "-ing" words	rixing	mixing
26.	short vowel "wh" words	whed	when
27.	long a-e words	dake	cake
28.	long i-e words	hime	dime
29.	long o-e words	fode	rode
30.	long u-e words	nube	cube
31.	long e-e words	scebe	scene
32.	ai words	taid	tail
33.	ee words	meed	need
34.	ea words	vead	read
35.	oa words	loat	boat
36.	ay words	tay	day
37.	ow words	drow	blow
38.	ar words	flark	shark
39.	ir words	fird	bird
40.	or words	sorn	corn
41.	ur words	hurn	burn
42.	er words	merb	verb
43.	ou words	lout	shout

44.	oo words	doon	moon
45.	ow words	fow	cow
46.	oi words	moil	soil
47.	oy words	goy	boy
48.	ew words	prew	grew
49.	au words	aulo	auto
50.	aw words	blaw	draw

APPENDIX B

Simulated Word Forms used in the Word Processing Teaching Strategies in the Experimental Study

	Simulated Word (1)	Simulated Word (2)*
1.	lat	nat
2.	hig	mig
3.	dut	fut
4.	mot	bot
5.	ped	sed
6.	clon	clom
7.	glap	blap
8.	skib	skif
9.	snad	snam
10.	breg	brug
11.	frek	freg
12.	prog	prof
13.	fent	gent
14.	jask	dask
15.	neld	seld

*(2) designates words added for simultaneous "patterns" training.

16.	jext	mext
17.	balt	selt
18.	gack	dack
19.	thib	thim
20	lath	dath
21.	fich	kich
22.	datch	satch
23.	shog	shod
24.	mung	bung
25.	rixing	sixing
26.	whed	whek
27.	dake	gake
28.	hime	sime
29.	fode	bode
30.	nube	dube
31.	scebe	sceme
32.	taid	taik
33.	meed	keed
34.	vead	mead
35.	loat	doat
36.	tay	fay
37.	drow	mrow
38.	flark	blark
39.	fird	vird
40.	sorn	forn
41.	hurn	surn
42.	merb	serb

43.	lout	mout
44.	doon	toon
45.	fow	gow
46.	moil	noil
47.	goy	doy
48.	prew	trew
49.	aulo	aupo
50.	blaw	plaw

APPENDIX C

Sentences used for Posttesting the Spelling of English Words

1. He wears a hat on his head.
2. The elephant is big.
3. A pecan is a nut.
4. A hot stove will burn.
5. Red is a color.
6. Don't clog up the sink.
7. The bird will flap its wings.
8. The sun can burn your skin.
9. The thorn will snag his shirt.
10. She will brag about her grades.
11. Don't always fret about your homework.
12. Go prod the dog with a stick.
13. Mother sent her to the store.
14. Come and bask in the sun.
15. He held the toy in his hands.
16. You are next in line.
17. Butter will melt in the heat.
18. Turn your back to me.
19. This is spelling.

20. We take a bath to get clean.

21. Rich people have money.

22. Use a match to light the fire.

23. The toy shop is open.

24. The doorbell was rung.

25. He is mixing the finger paint.

26. When will you behave?

27. I like chocolate cake.

28. A dime is money.

29. She rode on the horse.

30. A cube of ice is cold.

31. A lake is a pretty scene.

32. The dog's tail is broken.

33. We need food to grow.

34. Please read the book.

35. The boat sank.

36. One day is twenty-four hours.

37. Blow the candles out.

38. A shark lives in the sea.

39. A bird can fly.

40. Corn is good to eat.

41. Fire will burn your skin.

42. A verb is part of a sentence.

43. Shout your name out loud.

44. The moon circles the earth.

45. We get milk from a cow.

46. Soil is the same as dirt.

47. A boy grows up to be a man.

48. The tree grew bigger.

49. An auto is a car.

50. Draw a picture for me.

VITA

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Candidate for the Degree of

Doctor of Philosophy

Thesis: THE EFFECTS OF TEACHING SIMULTANEOUS OR SUCCESSIVE WORD PROCESSING STRATEGIES ON READING RECOGNITION AND SPELLING IN STUDENTS DEFICIENT IN EITHER SIMULTANEOUS OR SUCCESSIVE PROCESSING SKILLS

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